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THE

ELECTRICIAN;

A WEEKLY JOURNAL

OF

TELEGRAPHY, ELECTRICITY, AND APPLIED CHEMISTRY.

VOLUME II.

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TO OUR READERS.

We have reached another of those resting points whence we may survey the results of our labours, and address ourselves directly to our readers. The present number completes the Second Half-Yearly Volume of the Electrician. "The latter part of their first year," it has been said, "is a critical period for young periodicals." By that time the enthusiasm with which an interesting novelty is initiated has cooled down; and the features which attend success or failure are generally pretty well recognised. At the period when the experiment of a class paper, devoted to Telegraphy, Electrical Science and kindred subjects, was first mooted, it was a matter of serious doubt whether the number of persons who could find a special interest in the application of what has been regarded as a somewhat abstruse branch of science, was sufficient to ensure even a very moderate amount of success in such an undertaking. At the present moment, the existence of a journal registering the progress made in the direction we have referred to, rendering this progress intelligible, and of interest, to the many, and becoming in some cases the pioneer, as well as the recorder of advancement, is acknowledged to be a necessity. We are happy, moreover, to be able at least to state, that the number of our readers has from the commencement steadily augmented, and is yet increasing; that there is evidence that the employment of electrical agencies, for several of the purposes to which they are applicable in Art and Manufacture, has received a stimulus from our endeavours to popularize the science; and that our confidence in the extension and increased practical usefulness of this science, as well as in its high importance as a branch of study, has been increased rather than diminished.

There are but few points to which we require specially to revert on this occasion. The questions of highest interest, practical and theoretical, are yet *in prospectu*. Within the next six months we anticipate subject matter of considerable importance, and progress at least commensurate with that which has taken place during the period over which our labours have extended. The construction of new forms of cables for submarine circuits, the application of improved principles for obtaining motive power by voltaic electricity, and the formation of valuable chemical compounds under electrical influences, may be mentioned as likely to engage our attention.

We take the present opportunity of thanking several contributors who have rendered valuable assistance in communicating the results of their experience and observation; thus contributing to the general interest of the paper, and adding to the common stock of knowledge.

32, Paternoster Row,
October 31, 1862.

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CONTENTS.

ABSORPTION of water by caoutchouc, 50
Aerial wires, insulation of, 21
Allan's deep sea telegraph cable, 67
An account of researches in electro-chemistry, 284
An electric telegraph in the year 1815, 102
A new projectile force, 33, 44
Animal "magnetism," 157
Application of galvanic electricity to the treatment of diseases, 117
Applied chemistry, 186, 219
Atlantic telegraph, the, 218
—— survey, the, 59
Atmospheric electricity, 262
Automatic telegraph instruments, 97

BONELLI'S electric silk loom, 17
—— telegraphic apparatus at the International Exhibition, 53
British Association for the Advancement of Science, 236

CABLES, testing, 100
Cadmium, on, 234
Captain Selwyn's system of laying submarine cables, 3
Carbonic oxide and nitrogen, 114
Charging different lengths of telegraph wire, on the periods occupied in, 160
Chemical theory of the voltaic couple, The, 253, 265, 277, 301
Colonial and foreign telegraphy, 36, 106, 141
Correlation of physical forces, The, 260
Correspondence, 10, 23, 36, 48, 60, 70, 83, 95, 107, 119, 132, 142, 154, 167, 179, 190, 203, 215, 225, 238, 251, 262, 275, 287, 307

DESCRIPTION of the automatic printing telegraph, 90
Discovery of the art of electro-decomposition of metals, 255
Discursive, 205
Dr. Lardner on the subjugation of the powers of nature to human uses, 233

ELECTRICAL illumination for lighthouses, 188
—— literature, 268
—— properties of the tourmaline, 66
Electric and International Telegraph Company, Report of the, 165
—— animals, 59, 80
Electro-magnetic engines, 21, 217, 244
—— metallurgy, 177
—— gilding, 138
—— silvering, 130
Elementary data for manufacturers, 26
Examination of various cables, &c., 305
Effects of voltaic electricity in restoring animal life, 287
Exhibition awards 255
Experiments on insulation, 18
Experiments, table of, 19

FIRE telegraphs on the continent, 272
Firing gunpowder by electricity, 219

GLYPHOGRAPHY, 31
Government telegraph contracts, 153
Gutta percha and India rubber, 112

HARRISON'S electro-magnetic printing press, 307
Hearder's printing telegraph, 138
Heavy and light telegraph cables, 6
Henley's magnetic-electric alphabetical telegraph, 129

INCREASED efficiency of lightning conductors, 258
Induction tables, 6
Inductive retardation, 5
Insulation, 5
International Exhibition, 7, 34, 77, 89, 102, 121, 124, 185, 220
Iron covered cables, 152, 176, 185, 201

LAYING of submarine cables, 243
Law intelligence, 22, 83, 238
Lightning conductors, 92

MAGNETIC experiments, some, 68
M. Becquerel, on the sulphate of lead battery of, 164
Meeting of the British Association, 253
Metallurgy of platinum, 245
Military telegraph table, 69
Miscellanea, 12, 24, 60, 72, 83, 96, 108, 120, 144, 156, 168, 180, 192, 204, 216, 228, 240, 252, 264, 288, 308
"Moral causes," 39, 200, 211
M. Robin's soirees, 259
Mr. Shepherd's electro-magnetic clocks, 211

NATURE of the forces that actuate matter, on the, 206
New atlantic telegraph, 46
Note on the theory of spherical condensers, 280
Notes and memoranda, 20

OBITUARY notice, 117
Ohm's law in the production of electro-magnetic effects, 100
—— laws, 181
On a unit of measurement for voltaic currents, 248
On some new phenomena, &c., 164, 174
On the allotropic states of oxygen, and nitrification, 140
On the comparative periods of charge of various lengths of submarine cable, 133, 145, 169, 182
On the conduction of the atmosphere, 302
On the electrical law of distance, 171
On the fundamental laws of Ohm and their susceptibility of improvement, 148
On the heat, &c., 237
On the influence of electricity upon vegetation, 254
On nerve force, 114
On the periods occupied in charging different lengths of telegraph wire, &c., 138, 194, 217
On the period occupied in effecting the static charge of similar consecutive lengths of cable, 121
On the practical bearing of electricity in submarine telegraphy, &c., 246
On the production of electric light for photographic purposes, 118
On the use of cylinders in laying submarine telegraphic cables, 43, 54
Outer covering for deep sea cables, the, 127
Ozone, 74

PATENT laws, the, 56
Persian Gulf cable, the, 307
Physical geography and hydrography of the Arctic Regions, 103
—— science, 93, 186
Polytechnic Institution, 132
Prices current of insulating materials, 10, 22, 35, 47, 59, 69, 82, 94, 106, 118, 132, 141, 153, 167, 179, 187, 202, 213, 223, 236, 251, 262, 287, 307
Professor Hughes's electric telegraph apparatus for printing in Roman type, 30
—— —— printing instrument, 236
Proceedings of societies, 56, 93
Progress of telegraphy, the, 187, 213

RAILWAY telegraphs, on, 162, 172, 195, 209
Recent patents, 36, 94, 119, 167, 223, 235, 283, 306
Record of the British Association 273, 282
Report of the Directors of the Telegraph to India Company, 134
Researches on metallic amalgams, &c., 20
Ricardo, J. L., Esq., M.P., 193
Rotary galvanometers, 229, 241
Royal Institution lectures, 48

SIGNALLING instruments, 87
Some considerations on the principles of electrical conduction and accumulation, 3, 16, 27, 40, 51, 64, 75, 87, 98, 109, 122, 146, 158, 169, 182, 197, 207, 231, 242, 266, 278, 302
South Aussralia, the colony of, 140
Speed of working telegraph lines, 19
Steps to theory by the practice of electricity, 1, 13, 25, 37, 49, 61, 73, 85.
Submarine cables, on testing, 230
—— telegraph cables, on the electrical qualifications requisite in long, 136
Suter, the family of the late Mr., 307

TABULAR statement, &c., 284
Telegraph Companies, the earnings of, 203
Telegraphic news, 10, 22, 36, 47, 59, 69, 107, 118, 142, 154, 167, 179, 188, 203, 213, 224, 238, 251, 276, 288, 308
Telegraphic grievance, 223
—— jurors for the International Exhibition, 63
—— delays, 194, 202
—— projects. 109
—— strategy, 220
—— transmission of Chinese characters, 218
Telegraph shares, 10, 22, 36, 50, 69, 83, 94, 118, 141, 167, 179, 187, 214, 223, 236, 251, 262, 287, 307
Telegraphy, 236
The galvanic circuit investigated mathematically, 258, 270, 279, 304
—— induction coil, 176
—— nail in the cable, 32
—— student, 8, 21, 35, 46, 82, 102, 112, 153, 199, 274
—— *Times* and submarine telegraphy, 9
—— universal telegraph, 151
Theory of cylindrical and spherical condensers, 271
To correspondents, 12, 36, 60, 84, 96, 108, 120, 132, 144, 156, 168, 180, 192, 204, 216, 228, 240, 252, 264, 276, 288, 308
Tornadoes and waterspouts, 111
Train signals, 5
Transmission of electrical signals through submarine conductors, 14

VISIT of the officers of the Japanese Mission to the Electric and International Telegraph Company, 22
Voltaic piles, on the electro-motive force of, 116

WIRE guages, 8

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The Electrician.

Vol. II. No. 27.—May 9, 1862.

CONTENTS:

	Page		Page
Steps to Theory by the Practice of Electricity	1	Heavy and Light Telegraph Cables	6
Captain Selwyn's System of Laying Submarine Cables	3	International Exhibition	7
Some Considerations on the Principles of Electrical Conduction and Accumulation	3	Wire Guages	8
Insulation	5	The Student	8
Inductive Retardation	5	The *Times* and Submarine Telegraphy	9
Train Signals	5	Prices Current of Insulating Materials	10
Induction Tables	6	Telegraph Shares	10
		Telegraphic News	10
		Correspondence	10
		Miscellanea	12
		To Correspondents	12

STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 302.]

192. If any of our readers has attempted to explore the forest of St. Germain, or any other of those French woods that are interminable more for their maziness than their magnitude, and has plunged *par hazard* into one of a half dozen rays of an *étoile* only to be led by it to a second centre of diverging roads pointing in each of its directions still to another further on, he may form a lively idea of the labyrinth of electrical subjects claiming elucidation at our hands; we cannot progress far in any course we may happen to take without coming to an *étoile* from which several subjects diverge, no two of which can we possibly take at the same time, while any one of them we may select in precedence of the others is sure to bring us to half-a-dozen branches, all demanding attention. We have taken this illustration from reminiscences that have long been associated in our ideas with electricity; for often while we have gazed from the spot mentioned across the beautiful valley of the Seine, upon the luxuriant slopes of Marly-le-Roi, have we recalled to mind the half-diffident surmise of the immortal Franklin, that lightning was electricity, and the well-grounded assurance of the village curé by whose intelligence the identity was there first practically established, and the dreaded bolts of the terrific Jupiter solicited to earth by a minister of peace, to render, in times not far distant from his own, a peaceful and magnificent service.

193. We must now go back a little; we found by experiment with the Volta's condenser, that when its two discs were placed at a short distance from one another, and one of them was charged with plus electricity, that disc, acting by induction on its fellow, dismissed from it a portion of its natural electricity inferior in quantity to its own plus charge. We had thus two facts that needed to be accounted for, namely, the *arrival* in one disc of the inductive action originated by its fellow, and also the *inferiority* of the charge of the negative disc to that of the positive one by which it was established. If our readers have fresh in memory what has already been said about the *propagation* and *projection* of induction, they will be able in great measure to anticipate what is now to be added; for they will perceive at once that induction acting between two parallel conducting surfaces, as in the case in question, though it be projected from one contiguous particle to another, is of a character not to be confounded either with that diffusion of the electrical attraction which establishes the artificial equilibrium, or with projection independently of intervening matter. Like the former, it is propagated from one particle to another that is contiguous to it, and which, when critically examined, only means that electrical attraction acts at the shortest possible distances, taking long ones when there are no shorter, while it is unlike it in all its other details. Induction along lines of particles, or bundles of such lines, has a distinct character of its own, not indeed with reference to its origin, but to its progress and results. If this theory could be satisfied by giving anything less than originating causation, we should point to the difference in figure of a plane surface, as compared both to a convex and a concave one, and say that it *ought* to have an intermediate influence in determining the effects of induction; we might even on that difference have founded mathematical demonstrations to prove such an intermediate influence, but after all, unless we had the causation to begin with, we should know no more about it than we did before.

194. We want our teaching to be fundamental, and therefore we will ask the student to remember that in every branch of physical science, involving *action* and *reaction* of any kind, it is necessarily true of them, that as they must always remain equal to one another, one may succeed the other through an infinite series of alternations; this is one of those physical axioms which we can no more disbelieve than the truths of geometry; and in every case in which the reaction seems to fall off or come to an end, it is because something has interfered, that unperceived by us, is supplying it in part or altogether. In our theory we have this never-ending action and reaction in what we have called the inductric and inducteous electrical conditions of matter, not indeed with respect to force, but quantity; not to force, because, as we have seen, by reason of the electrical law of quantity, any particle of common matter under induction may have two different amounts of intensity, the greater one inducteous, and looking back to its cause (par. 75); the lesser one inductric, and looking forward towards its effect; but even in those cases, as we understand, the quantity of electrical charge, however far the induction extends, is always constant. We hope it will be clearly understood what we mean by quantity of charge; we shall make it very distinct by defining it with reference to the particles of common matter, and also particles of electricity. Suppose five particles of common matter to have been deprived of ten particles of electricity; then the former will have a negative charge, and the latter will confer a plus charge on whatever they may be temporarily connected with, and these two charges will be equivalents one of the other. Imagine, further, that the ten particles of plus electricity are acting by induction at different times on five and ten particles of common matter, they will, as a charge, be equal in quantity to the induced negative charge in either case, although in one of the cases the quantity of electricity virtually dismissed from each common particle will be double what it is in the other case, the intensity of its attraction being in consequence quadrupled.

195. But in every particle of a line, or bundle of lines, we have equality of intensity as well as of quantity, the inducteous action impressed upon it, and the inductive action setting out from it being in quantity, and therefore in intensity, necessarily constant. It is such a bundle of lines that we have to do with in the cylinder of air that intervenes between the charged and the uninsulated discs of the condenser now under consideration, for the successive surfaces that would be exposed by different sections supposed to be made across that cylinder, would all contain the same number of aërial particles, and, consequently, at every part of the cylinder the induction would be handed forward, and become finally impressed upon the uninsulated conducting surface, without any change of the original intensity.

196. Let it, however, be remembered that in stating this we are only taking into account the flat surfaces of the condenser that are opposed to one another, irrespective of the outer surfaces and perimeters, the inductive atmospheres of which involve other and distinct considerations.

197. Having thus shown how the inductive action is communicated from the charged to the uninsulated discs of a condenser, it remains to be explained how it is that the inducteous charge of the one becomes inferior to the inductric charge of the other, as well as the circumstances by which the amount of difference is determined. With respect to the existence of inequality, the cause for that will be perceived in the presence of an inductive atmosphere against certain parts of the charged disc under circumstances that enables it to support part of the induc-

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tion of the plus electricity by establishing *for that part* an artificial equilibrium, and thereby diverting it from the direction of the uninsulated surface. We may, therefore, come at once to the cause of the different degrees of inequality.

198. And first let us have the facts of the case. It was shown practically by experiments 25, 26, and 27 (par. 161), that when the discs of the condenser were separated by distances varying as the series 1, 2, and 3, the quantities of electricity dismissed from the uninsulated disc by as much of a given charge on its fellow as could have its induction propagated to it, varied as 1, $\frac{1}{2}$, and $\frac{1}{3}$; now the theoretical causation will easily be made manifest by an inspection of the following figures, in which the charged disc of a condenser is represented to be enveloped in three different thicknesses of inductive atmosphere, increasing in a simple ratio, as would be determined by placing the uninsulated disc of the instrument successively at one, two, and three units of distance from its fellow.

Fig. 28.

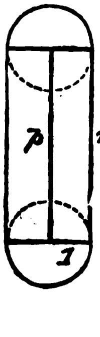


Fig. 29.

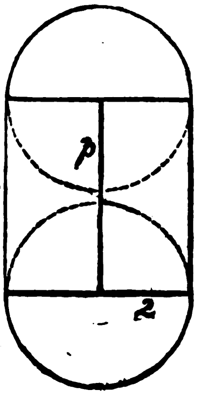
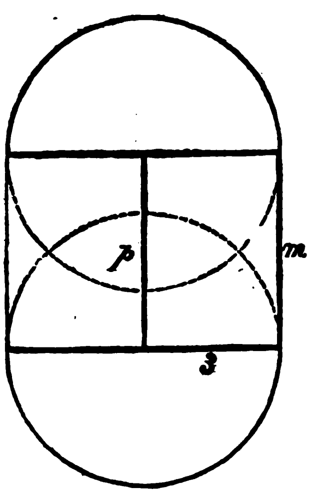


Fig. 30



In using each of these diagrams, what we have to bear in mind is, first, that the minus charge in *m* will be equal to the plus charge in *p*, less that portion which is setting up the artificial equilibrium by acting inductively upon the atmosphere; and secondly, that the portions thus acting to establish the artificial equilibrium will be relatively represented by the extent of the *bounding surface* of the inductive atmosphere. Now we have just seen that a cylinder of air abutting against a charged surface can as a whole act with no such effect, and, therefore, we may omit from our calculation two such cylinders appertaining to each of the figures, one against the inner and the other against the outer side of the charged disc. Consequently, we shall confine our attention to the perimeters of the discs and their inductive atmospheres; and it will be quite evident that at one, two, and three units of distance from any point of a perimeter, we shall have near enough for our purpose aërial surfaces bearing that same proportion, because as the circumferences of circles are to one another as their radii, so also must be their semi-circumferences implicated in our diagrams. Now, $1\times1=2\times\frac{1}{2}=3\times\frac{1}{3}=1=$ the sum of the charge under artificial equilibrium, plus the charge set up in the uninsulated disc, in each of the instances.

199. It would have been an event perfectly accidental, if, while the nature of static electrical induction remained unknown, it had not been sometimes imagined to operate where it did not, or have been otherwise than imperfectly traced where it was known to be; while it was supposed to be intimately related to all electrical phenomena whatsoever, and its connection with them on mechanical principles could in no one instance be shown, it could hardly have failed to be a prolific source of mischief, and to its account must be laid in one form or another nearly the whole of the modern embarassments that electricians have found to obstruct their progress. We will, therefore, although at some risk of being chargeable with needless repetition, apply our theory of induction to the Volta's condenser.

Exp. 32. Set the discs of the condenser about one inch apart, both of them being insulated, and connect them each by means of a metallic or moistened thread with a gold-leaf electrometer; touch their edges both at the same time by an insulated charged conductor, so as to cause in the gold leaves just a sensible divergence, and then push the charged discs further from one another; as they recede the divergence of the gold leaves will diminish and finally cease altogether.

Fig. 31.

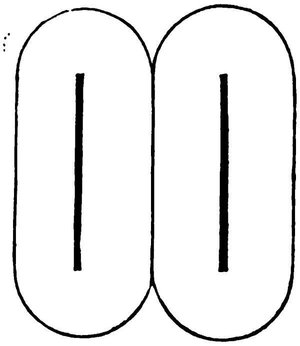
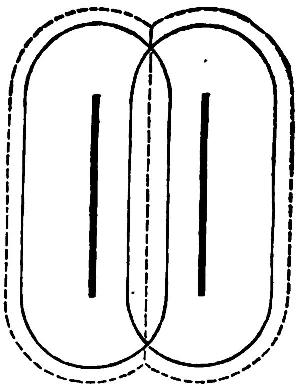


Fig. 32.



200. Each of the preceding figures represents in section the discs of the instrument, with their inductive atmospheres, all other parts not implicated in the electrical action being suppressed. In the former the discs appear separated by just so great a distance that each can be surrounded by an inductive atmosphere of uniform and sufficient thickness to reduce the

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intensity at its extreme boundary to inappreciability; thus establishing a state of things that on all practical considerations we have thought it convenient to call artificial electrical equilibrium. The other figure shows the discs at their nearer distance, that is to say, not far enough apart to confer upon their opposed surfaces the same thickness of inductive atmosphere as is demanded by all their parts for holding the same charge under the same amount of intensity. The intercepting portions indicate that the inductive atmospheres need to be extended, as shown by the dotted lines, in the other possible directions, and with that necessity for extension an increase of intensity making the angle of divergence to become sensible.

(To be continued.)

CAPTAIN SELWYN'S SYSTEM OF LAYING SUBMARINE CABLES.

On Friday last Captain Selwyn, R.N. read a paper at the United Service Institution "Upon the use of Cylinders in laying Submarine Cables." It will be remembered by many of our readers that in Captain Selwyn's plan, which has for some time been made public, the cable as it is manufactured is wound upon a huge reel, and from that time remains permanently immersed in its proper element, water; the reel being subsequently taken in tow, and the line allowed to unwind itself in the path taken by the vessel. We must confess that the idea appeared to us, on first consideration, to be somewhat crude and primitive, if not preposterous. What, for instance, would be the size and weight of a cylinder which would carry an Atlantic cable, its *vis inertia*, and its behaviour to the vessel, which, for better or for worse, would be united to it in a journey across the ocean? What the effect of leakage in the cylinder, of a temporary stoppage *en route*, or of the parting of one or both of the towing hawsers? We are bound to say that these questions and many others are satisfactorily answered by Captain Selwyn, who has evidently given careful study to the problem he has taken up. We shall, in an early number, give *in extenso* the explanation and remarks in the paper referred to. In the meantime, we may point out that the principal objection which has been made against this system of laying cables has really no existence. The part taken by the vessel in laying the cable is mainly to trace the route of the latter, and to maintain the cylinder in a position at right angles to this line. The cable, in this system, actually lays itself by the action of uncoiling from the reel. This will be seen when it is explained that the ends of the cylinder are furnished with paddles,—the floats of which, by a simple mechanical contrivance, are moveable in the direction of the radii, and that one-third of the cylinder only is immersed. The suspended weight of a comparatively short length of cable is therefore sufficient to cause the revolution of the cylinder, and this revolution is converted into a forward motion by the action of the paddles, which, as we have seen, is susceptible of being regulated within considerable limits. It was pointed out by Capt. Selwyn, that the objections against his system from different quarters were, in several instances, diametrically opposed to each other, involving contradictions which certainly go far to neutralize these objections. Thus, a well known and able mathematician, on having the plan explained to him, pointed out that there was some probability of the cylinder "running over the vessel," instead of its operating as a dead weight to impede its progress. But we cannot seriously consider this catastrophe as probable, or even possible, as the means for its avoidance appear tolerably obvious.

One of the most serious matters for consideration, is the effect of the strain of the cable shifting from one to the other extremity of the cylinder. It is obvious that the action of the paddle at that extremity of the cylinder which, *pro tem.*, supports the strain of the cable, will be increased, from the fact of its increased immersion. Whether this compensation would be sufficient to preserve the position of the cylinder, is a question which we must refer to the calculations and experiments of those who may be able to afford further data in regard to a system which, upon due consideration, appears to be based upon an ingenious and efficient combination of mechanical agencies.

It should be stated that Capt. Selwyn's system of laying cables has already been submitted to experimental trial, on a scale between the working conditions of a model and those of actual practice, and that the trial appears to have been most satisfactory. We have, therefore, good grounds for assuming that this system is deserving of an impartial and careful comparison with that which has hitherto been adopted; albeit, the shortcomings which have rendered the latter so disastrous are now very generally understood, and may, therefore, be avoided in future. The method proposed by Capt. Selwyn obviates, moreover, any risk of deterioration of the cable from the time it leaves the manufacturer's hands to the period of its actual submersion. The cylinder on which it is wound may readily be made constantly to revolve in water, admit of easy transport, and submits the cable to what is now recognized as the most severe and the only necessary condition for testing, *viz.*, simple immersion in water.

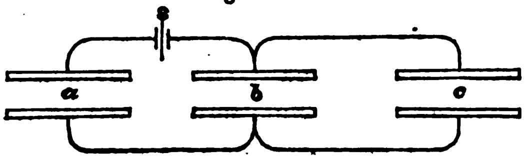
SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 294.]

Let the pairs of plates a, b, and c all be equal in surface, and let the distance separating any pair of plates be the same in all, then their resistance will be equal in all.

Fig. 58.



Let the surface of a single plate in each of the pairs equal 10, and let the resistance, r, r', and r'', respectively of each pair equal 10.

And let Q, the quantity on $a=10$,
Then must q, the quantity on $b=5$,
And p, the quantity on $c=5$.

The density on a will be $\frac{10}{10}=1{\cdot}0$

" b and c $\frac{5}{10}= {\cdot}5$

The resistance of the whole inductive circuit will be

$$R=10+\frac{10\times10}{10+10}=10+\frac{100}{20}=10+5=15$$

Let the resistance of a be now increased 6 times by decreasing the surface of the plates a to one one-sixth their former surface, then r will equal 60, and the resistance of the whole circuit will be by equation 7

$$R'=60+\frac{10\times10}{10+10}=60+\frac{100}{20}=60+5=65.$$

The quantity on a, after being altered will be found by the equation

$$Q'=\frac{RQ}{R'} \qquad (8)$$

$$\text{or, } Q'=\frac{15\times10}{65}=\frac{150}{65}=2{\cdot}307$$

2·307 is, therefore, the sum of the quantities on b and c. But this will be divided between the plates b and c inversely as their resistance, and as they are equal in resistance, the quantity on each is $q'=1{\cdot}153$, and $p'=1{\cdot}153$.

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The density on a will be $\frac{2\cdot307}{1\cdot66}=1\cdot38$,

and on b and c ·115.

In this example, the resistance being increased, the quantity is decreased, but as the increased resistance is caused solely by the surface of a being decreased, the density on the plates a rises; but as the plates b and c remain unaltered whilst the quantity is decreased, the density on them falls.

Suppose, now, a, b, and c all unequal in surface, but separated from their opposing plates a unit of length.

Let the surface of $a=15$, of $b=8$, and of $c=13$. Then supposing a plate having one hundred units of surface separated one unit of distance to be a unit of resistance. The resistance of plates a $(r)=6\cdot66$

b $(r')=12\cdot5$

c $(r'')=7\cdot69$.

Then the total resistance of the inductive circuit will be

$$R=6\cdot66+\frac{12\cdot5\times7\cdot69}{12\cdot5+7\cdot69}=6\cdot66+\frac{96\cdot12}{20\cdot19}=6\cdot66+4\cdot76=11\cdot42.$$

Let Q, the quantity on $a=10$.

Then the quantity on $b+c=10$; but this will be divided inversely as their resistances.

The quantity on b (or q) $=\frac{7\cdot69\times10}{7\cdot69+12\cdot5}=3\cdot8$,

and quantity on c (or p) $=Q-q=6\cdot2$.

The density on $a=\frac{10}{15}=0\cdot66$

that on $b=\frac{3\cdot8}{8}=0\cdot47$

that on $c=\frac{6\cdot2}{13}=0\cdot47$

Suppose a now increased in surface 8 times, then its resistance will be reduced to one-eighth its former resistance, or $r=0\cdot83$

Then $R'=0\cdot83+4\cdot76=5\cdot59$

and, by equation 8, Q′, the quantity on $a=\frac{11\cdot42\times10}{5\cdot59}=20\cdot4$,

20·4 is also the quantity on $b+c$, but this will be divided between b and c inversely as their resistance or

The quantity on b, or q', will be $\frac{7\cdot69\times20\cdot4}{7\cdot69+12\cdot5}=7\cdot77$.

The quantity on c, or p', will be $Q'-q'=12\cdot63$.

The density on a will be $\frac{20\cdot4}{8+15}=0\cdot17$

" " b " $\frac{7\cdot77}{8}=0\cdot97$

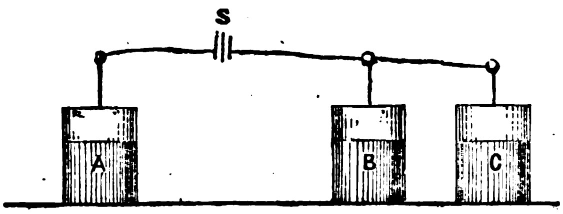
" " c " $\frac{12\cdot63}{13}=0\cdot97$.

In this example the increase of surface of the common resistance increases the total quantity, but decreases the density on the common resistance, and increases the quantity in the two branches in the same ratio in both, so that they still retain the same ratio to one another.

Furthermore, as the distances between the plates b and c, and their opposing plates, are equal, the density on both is alike, and when the resistance of a is decreased the density on b and c rises, but equally in both.

Thus if a Leyden jar A (fig. 54) has its interior connected to the one pole of a source, the other pole of which is connected to the interiors of two other jars, B and C, whilst the exterior coatings of all are connected together, then a certain accumulation will be effected. The quantity in A will equal that in B+C, and this quantity in B and C will be divided between them in the inverse ratio to their inductive resistance, and if the jars B and C are of equal thickness, then the division will be directly as their surfaces. If now A be increased in surface (without altering its thickness), the inductive resistance of the whole circuit will be decreased, and the quantity in B and C will be increased, but will be increased in both in the same ratio, thus if the quantity in B is

Fig. 54.



doubled by the alteration of A, the quantity in C will also be doubled.

If one of the branch resistances be altered, then the total quantity on the two branches will be altered, and will be disposed on those two surfaces in the inverse ratio to the new resistances of the two branches.

Thus let r, r', r'', as before, equal respectively the resistances of a, b, and c, the plates a being the common resistance; and let Q equal the quantity on the common resistance plates.

Then $R=r+\frac{r'\,r''}{r'+r''}$.

If r' be now increased m times, then

$$R'=r+\frac{m\,r'\,r''}{m\,r'+r''},$$

and Q′ as before $=\frac{Q\,R}{R'}$

Therefore, suppose as before, the plates a, b, c, to be all equally separated from their opposing plates, and let the surface of $a=15$, of $b=8$, and of $c=13$, then taking the same unit of resistance as before,

$r=6\cdot66$, $r'=12\cdot5$, $r''=7\cdot69$,

and $R=11\cdot42$,

$Q=10$; then $q=3\cdot8$, and $p=6\cdot2$.

Let density on $a=0\cdot66$,

" " $b=0\cdot47$,

" " $c=0\cdot47$.

Let now the resistance of r' be decreased by decreasing the distance between its plates b to one-sixth their former distance, then

$$r'=\frac{12\cdot5}{6}=2\cdot08.$$

and $R'=6\cdot66+\frac{2\cdot08\times7\cdot69}{2\cdot08+7\cdot69}=8\cdot27$,

and, by equation 8, $Q'=\frac{10\times11\cdot42}{8\cdot27}=13\cdot8$

13·8 equals the sum of the quantities on b and c, but these will be divided inversely as their resistance, or

$q'=\frac{13\cdot8\times7\cdot69}{7\cdot69+2\cdot08}=10\cdot86$,

and $p'=Q'-q'=2\cdot94$.

Therefore the density on $a=\frac{13\cdot8}{15}=0\cdot92$,

" " " $b=\frac{10\cdot86}{8}=1\cdot35$,

" " " $c=\frac{2\cdot94}{13}=0\cdot22$.

In this case, therefore, the decrease of the total resistance has increased the quantity and the density on a, and has increased the quantity and density on b, but has decreased the quantity and density on c.

In the case of the three Leyden jars shown in figure 54, if the jar B be replaced by a jar B′ of the same surface, but thinner, the quantity in A will be increased, and its density increased, and the quantity in B′ will be greater than in B, and the density

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greater, but the quantity in c will be less, and the density less than before.

Suppose now the resistances r' had been decreased by increasing the surface of the plate b six times, then the quantities on the plates would become as in the last case.

On a or $Q' = 13{\cdot}8$,
„ b „ $q' = 10{\cdot}86$,
„ c „ $p' = 2{\cdot}94$,

and the density would be on $a \frac{13{\cdot}8}{15} = 0{\cdot}92$,

$$\text{and on } b \frac{10{\cdot}86}{8 \times 6} = 0{\cdot}022:$$

$$\text{and on } c \frac{2{\cdot}94}{13} = 0{\cdot}22.$$

Thus if the jar B be replaced by one B″ six times its surface, but of the same thickness as that of B, the quantity in A would be increased, and its density increased. The quantity in B″ would be greater than that in B, but the density would be less, whilst both the quantity and density in c would be decreased.

(*To be continued.*)

INSULATION.

BY ALED.

The readers of The Electrician must from time to time have been either edified or amused, or both, by the vigorous contest carried on between its redoubtable correspondents, "P. Q." and "Momus." The comparative merits of gutta percha and india rubber as insulators have been discussed, it must be confessed, with considerable ability on both sides; but it would have been well had the disputants taken the trouble to read over a few pages of the Government Telegraph Committee's report. The question of insulation is evidently but little understood, if we are to be guided by the statements of practical men. Mr. J. T. Henley states (2,414):—"It is well known that a perfect, fully insulated wire retards the current more than one that is just faulty enough to allow the charge to return to earth."

Mr. Siemens says (3,501), "We speak better through a moderate insulated wire when the leakage is not sufficient to interrupt rapid communication."

Mr. Varley states (2,915), "I should here state that when a line is defective in insulation (and we will for argument sake assume that the amount of defective insulation or resistance be constant) the speed of the wave is increased thereby."

When we thus find that gentlemen of the highest repute as practical telegraphists declare that a certain amount of insulation is all that is necessary for the rapid transmission of a working current along a submerged cable, we should no longer attach any value to very high insulating capacities, but rather to the power of the material employed to maintain the amount of insulation requisite for practical purposes. If, comparatively speaking, a moderate insulation enables us to transmit signals with greater rapidity, the desideratum in that case is the possession of a material not liable to be deteriorated by the current, so as to increase its conductivity. This is an important question, and deserves a thorough investigation.

INDUCTIVE RETARDATION.

The following very lucid and practical remarks of Mr. Latimer Clark, in his report to the Board of Trade Committee, afford most essential *data* for the construction of submarine cables, with due regard to economy and rapidity of signalling; it being borne in mind that the amount of inductive discharge diminishes as the battery tension employed in working a cable is decreased.

"By doubling the diameter of the copper wire, we only increase the induction by about one-half, while we increase its power of conducting electricity four times. On the other hand, if we double the thickness of the insulator, we only diminish the induction about one-third, but do not increase its conducting power at all. Provided, then, sufficient thickness of the insulating material is employed to ensure its electrical security, every advantage is to be obtained by increasing the weight of the conducting wire, rather than that of the outer coating.

"In a pecuniary point of view the gain is very great. Let it be supposed, for the sake of example, that it were desirable to double the rate of working of the Gibraltar or Rangoon cable. This consists of 400 lbs. of copper and 400 lbs. of gutta percha per nautical mile; its diameter is half an inch, and its value may be estimated as 400 lbs. of copper at 1s. 6d. per lb., and 400 lbs. of percha at 3s. 6d., or £100 per mile; its actual cost was £98. If we confine our operation to the gutta percha alone, increasing its thickness to such an extent as to diminish the induction one-half, we should have to make its thickness about 1¼ inch, and to add about 3,500 lbs. of additional percha, at a cost of about £612 per mile. If, on the other hand, we enlarge the copper conductor, merely increasing the percha to a sufficient extent to maintain the same thickness of covering, we should require the addition of about 670 lbs. of copper, at 1s. 6d., and 455 lbs. of percha, at 3s. 6d., making the total additional cost only £130 per mile. But we gain a collateral advantage, in this latter case, of the highest importance. Not only would the current or wave make its appearance at the distant end in the same time as in the former, but when it did arrive it would have more than double its volume or quantity, and consequently more than twice its strength; or it would permit us to reduce the battery power more than half, and still obtain a current of the same strength and in the same time; and it is of course a point of the highest importance to the permanence of a cable to work with as low a battery power as possible."

TRAIN SIGNALS.

The following is a description of Mr. Edwin Clark's arrangements for train signals, as now adopted upon several of our railways:—

There are two telegraph instruments in each signal station; one devoted solely to trains on the up line, and the other for the down line, as engraved upon the instruments.

There are similarly two semaphores of the usual construction.

Each instrument has two dials, over which are placed the names of the stations with which they communicate, and which are always the next up and down stations upon the line.

A signal is made by permanently holding the needle over to the right or left, or by continually moving the needle to the signal required.

If the needle suddenly becomes vertical, and no motion of the needle takes place on moving the handle either to the right or left, it indicates either that the telegraph is broken down, or the wire disconnected by the guard of some train travelling upon the line, to warn the signalman that the line is blocked. Under such circumstances, no other train must be allowed to proceed on the line without being stopped and warned of the danger by means of the semaphore.

Each needle, therefore, makes three signals:—

1. Needle to the left, signifying, "*Train on the line.*"
2. Needle to the right, signifying, "*Line clear.*"
3. Needle vertical, signifying, "*Line blocked and impassable.*"

Each "up line" instrument, on giving the signal "Train on the line," rings a bell at the next up station, to call attention to the approach of a train, and upon hearing this, the next signalman blocks the needle to "Train on the line," to acknowledge the signal.

Each "down line" instrument similarly rings a bell at the next down station for a similar purpose.

The approach of a train is thus always preceded by the ringing of a bell, and its departure is similarly signalled on by the ringing of the bell at the succeeding station; the necessary signal is then given, and the signal remains permanent until it arrives at the station which it is approaching.

The dials show at all times, and at every station, whether there are any trains either on the up or down lines, between the next up and down stations.

No obstruction on the line will be allowed if the up and down lines are not both shown on the dial as "Line clear."

All trains on passing the telegraph station, are warned by the position of the semaphore, as follows:—

1. That there is a train ahead, and not yet arrived at the succeeding station; or
2. That the line is clear; or
3. That an accident has happened, and the line is blocked; and instructions are given to the guards accordingly.

POSITION OF THE INSTRUMENTS.

The instruments are placed side by side, and, when possible, to be placed in their natural position; that is, the up line instrument to be nearest to the next up station, and the down line instrument to the nearest down station.

The instruments will have a switch between them, so that on leaving them at night, or at other times, they are taken out of circuit, and the circuit rendered complete without communication with the station thus cut out.

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Ordinary communications between station and station can be made by single needle, but on no account to be allowed to interrupt the permanent train signals. No communication will, therefore be allowed, unless the dial at the time indicates "Line clear;" and the communication must cease immediately a train is approaching, and the signal, "Train on the line," is given.

Any derangement of the wires or instrument must be signalled to the nearest telegraph station of the Electric Telegraph Company, linemen will at once attend and remedy the defect; but the signalman himself must not, under any circumstances, attempt to rectify any serious fault, or alter the connections of the instruments, as any mistake in the connections might be the cause of the most serious result.

INDUCTION TABLES.

The following tables, showing the calculated and experimental induction discharge or retardation upon conductors of various dimensions, and coated with different insulating materials, may prove serviceable to those engaged in their manufacture. The last column shows the actual result of experiment, in which a very delicate and reliable galvanometer was employed. The length of the experimental wire in each case being one statute mile.

TABLES SHOWING THE INDUCTION DISCHARGE OF VARIOUS CORES.

Plain Gutta Percha.

Dia. of Copper.	Thickness of Covering.	Calculated Discharge.	Experiment Discharge.
in.	in.	°	°
3-32ths	3-32ths	27·	24·
"	4-32	24·	
"	5-32	21·5	
"	6-32	18·18	18·
"	7-32	16·45	
"	8-32	15·60	
"	9-32	14·58	
"	10-32	13·5	
"	11-32	12·87	
"	12-32	12·14	12·
4-32	3-32	18·	18·
"	4-32	16·	
"	5-32	14·25	
"	6-32	12·18	12·
"	7-32	10·92	
"	8-32	10·4	
"	9-32	9·72	
"	10-32	9·	
"	11-32	8·25	
"	12-32	8·16	8·
2-32	3-32	11·19	11·2
"	4-32	9·76	
"	5-32	8·7	
"	6-32	7·44	7·8
"	7-32	7·14	
"	8-32	6·90	
"	9-32	6·372	
"	10-32	5·9	
"	11-32	5·501	
"	12-32	4·89	5·8
India Rubber.			
2-32	3-32	7·5	7·5
"	4-32	6·64	
"	5-32	5·90	
"	6-32	5·05	5·
"	7-32	4·55	
"	8-32	4·328	
"	9-32	4·15	
"	10-32	4·09	
"	11-32	3·74	
"	12-32	3·612	
Gutta Percha (Improved).			
2-32	3-32	7·98	8·
"	4-32	7·08	
"	5-32	6·82	
"	6-32	5·4	5·8
"	7-32	5·25	
"	8-32	5·	
"	9-32	4·68	
"	10-32	4·33	
"	11-32	3·96	
"	12-32	3·6	

MR. NEWALL ON HEAVY AND LIGHT TELEGRAPH CABLES.

Minutes of Evidence taken before the Submarine Telegraph Committee.

Does your experience lead you to think that a heavy cable is safer to lay down?—As we have laid successfully the lightest cables that have been attempted to be laid, I think that the weight is not necessary or desirable, unless near the shore.

(*Mr. L. Clark.*) Do you consider that there is more risk in laying a heavy cable than a light one in deep water?—That depends altogether upon the situation. If the means for controlling its going out of the vessel are adequate, I do not see any danger in laying a heavy cable. We have laid the heaviest cables that have been laid 13½ tons a mile.

(*Chairman.*) If you were laying a cable to America and you had a proper ship, would you have much hesitation in laying an iron cable?—That would depend upon the weight. I would not, I think, hesitate in laying it; but I would not lay an iron wire covered cable there. I think it would be an unnecessary expense.

When once the cable reaches the bottom, do you think it is safe in deep water?—I think it is comparatively safe. If Mr. Brett had the information as regards laying cables, and the machinery suited for the purpose that I have invented, I think he could have laid that 7½ tons cable across from Cagliari to Bona in perfect safety.

That would be in about 1,500 fathoms?—Yes; Mr. Brett has been misinformed in stating that there are upon that line a sort of irregular sudden depths which we call Mr. Brett's precipices. He thought he had discovered several in laying down the cable, or he supposed that there were such from the sudden flights of the cable uncontrolled from the ship. We found in sounding the line across that it was nearly a dead level, with a fine muddy bottom, and that there were no precipices in existence there or anywhere else on the bottom. The French Admiralty have made correct soundings of it under the direction of Mr. Delamarche.

From your own experience in the Mediterranean and the Indian seas, there is no sudden depth entitling it to the name of a precipice or anything approaching to it?—Just so.

In the Red Sea is there not something of the sort owing to the coral?—Yes, near the shore, but only near the shore in very shallow water. There I have seen a precipice. You may walk in in two feet of water, and then suddenly from the edge of the coral it goes down to a great depth.

Where the water gets deep the silt has accumulated has it not?—Yes, it is deposited gradually. It is therefore nearly a dead level I believe all over the world. It is generally stated that the bottom of the sea somewhat approaches the nature of the adjoining land, but that does not hold. In places where we have high hills, for instance, there are high mountains in Wales and Wicklow, but the bottom of the sea in the Irish Channel is nearly a dead level of 45 fathoms: and the same is the case in the German Ocean; it is nearly a dead level, and silt or mud is deposited gradually and equally, unless there is a strong current. There is a strong current between Port Patrick and Donaghadee, where we have laid two heavy cables. They cross the channel where there is a sort of ditch scooped out by the action of the current to a depth of 150 fathoms, where the adjoining soundings are about 100 fathoms; but still that is not a sudden precipice, it is a slope. The deepest water that we have successfully laid cables in has been across the Persian Gulf, at a depth of 2,000 fathoms.

(*Mr. L. Clark.*) You laid down a portion of hemp cable, did you not, in the Alexandrian line, which failed?—In the Levant we laid down a cable covered with hemp alone, in order to test practically that form of cable.

Did you gain any useful experience in that instance?—Yes, we found that it would not answer in that part of the Mediterranean Sea, because when we took it up a few months afterwards we found that the hemp was completely eaten through by marine insects, the teredo.

(*Chairman.*) In what depth was that?—It was in deep water, some of it 1,100 fathoms.

(*Mr. L. Clark.*) Even at that depth do you think that the teredo had eaten it?—No, it was in shallower water that the toredo had eaten through the hemp.

Had you any difficulty in laying that simple hemp cable?—None whatever. We laid 300 miles across the stormy Black Sea, from Varna to the Crimea, with no covering whatever but gutta percha ¼ inch thick. I think there is no difficulty if the apparatus for paying it out be suitable for the cable.

Had you good weather in laying down the Varna cable?—Tolerably fair weather.

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And the Alexandrian hemp cable also ?—Mr. Liddle laid down the Crimean cable and the Levant cable, and in laying down the Levant cable he had very rough weather.

As the result of the whole of your experience you think that with proper skill and suitable machinery, either heavy or light cables might be laid in deep water ?—I think so.

(*Chairman.*) For very deep water if the cable is likely to be perfectly safe at the bottom, there would appear to be no objection to laying it without any outer covering at all ?—From our experience in laying the Red Sea cable, and finding that the iron wire is now completely corroded off it in various places, I think that it is worse than useless putting it on in any water, except in very shallow water, and near the shore, to guard it against ships' anchors. I would still guard the cable with very heavy iron near the shore, but in deep water I think any outside covering is useless.

International Exhibition.

INSTRUMENTS, APPARATUS, &c., ILLUSTRATIVE OF THE PROGRESS OF ELECTRICAL SCIENCE.

ENGLAND.

CLASS 13.

Allan, T., 1, Adelphi Terrace.—Automatic telegraph, electro-magnetic engine, submarine cables, &c.

Bellhouse, W. D., 1, Park Street, Leeds.—Medical galvanic apparatus.

Bolton and Barnett, 146, Holborn Bars.—Chemical, galvanic, and pneumatic apparatus.

Brett, J. W., 2, Hanover Square.—Submarine telegraph cables, Roman type printing telegraph.

British and Irish Magnetic Telegraph Company, Liverpool.—Telegraphic instruments, submarine cables, &c.

Clark, G., 80, Craven Street, Strand.—Improvements in electro-telegraphic cables.

Duncan, C. S., Monmouth Road, Bayswater.—Rattan deep sea electric telegraph cable.

Elliott, Brothers, 30, Strand.—Philosophical and surveying instruments, &c.

Elliot, Glass, and Co., 10, Cannon Street, London.—Electric submarine telegraph cables.

Hart, W. D., North College Street, Edinburgh.—Electrical apparatus.

Henley, W. S., 46, St. John Street Road.—Magnets and magnetic instruments, &c.

Holmes, S. H., Northfleet, Kent.—Magneto-electrical machine and light, lighthouse regulators.

Ladd, W., 12, Beak Street, W.—Focimeter for lighthouses, induction coils and apparatus, microscope, with magnetic stage, air pump.

Pulvermacher, J. L., 78, Oxford Street.—Galvano-piline, a self-supplying galvanic battery.

Reid, Brothers, 25, University Street, W.C. — Electric telegraph materials.

Rogers, J., 216, Gresham House, City.—Telegraph wires and cables.

Sharp, E. B., Hanwell Park, Middlesex.—Submarine electric telegraphs, paying out machinery, &c.

Siemens, Halske, and Co., Great George Street, Westminster.—Telegraph apparatus for land and sea lines.

Silver, S. W. and Co., 3, Bishopsgate Street.—Electrical machine fitted with ebonite.

Smyth, C. P., Edinburgh.—Electric registering anemometer, &c.

Spratt, J., 118, Camden Road Villas.—Lightning conductors, &c.

Submarine Electric Telegraph Company, 58, Threadneedle Street.—Samples of their submarine cables.

Tyer, E., 15, Old Jewry Chambers.—Train signalling telegraphs, &c.

Universal Private Telegraph Company, 448, Strand —Wheatstone's magneto-alphabetical telegraphs for railways or private use.

Varley, C. F., 4, Fortress Terrace, Kentish Town.—Telegraph apparatus, insulators, batteries, electrometer. &c.

Vulliamy, L. L. and H. P., Clapham Common.—Model of electro-magnetic motive engine.

Walker, C. V., Fernside, Redhill.—Telegraph train signals.

Watson, H., Newcastle-on-Tyne.—Armstrong's hydro-electric machine.

Wells and Hall, Mansfield Street, Southwark.—Telegraph conductors, submarine cables, and wires for magnetic cores.

Wilde, H., St. Anne's Square, Manchester.—Alphabetic dial telegraphs, worked by magnetic electricity.

Young, J., Dalkeith.—Carbon for electrical batteries, and electrodes for electric light.

CLASS 8.

Hurry, H. C., Rookswood Villa, Worcester.—An electro-magnetic motive engine.

Shephard, E. C., Victoria Street, Westminster. — Magneto-electric machine for electric light, &c.

BELGIUM.

CLASS 13.

Bultinck, E., Ostend.—Electro-galvanic apparatus, with inodorous acid, giving any required current.

Gerard, A., Liege.—Electric clock, electric battery, an electro-magnet.

Gloesener, M., Liege.—Chronoscopes, registering multipliers, an electric clock.

Jaspar, Liege.—Doctor Stacquez's "electro-medical," a regulator of electrical light.

Lippens, P., Brussels.—Telegraph apparatus, and requisites for telegraphic lines.

DENMARK.

CLASS 13.

Danish Slate Telegraph, Copenhagen.—Isulators and galvanic battery.

Kyhl, C. C., Copenhagen.—Relays and translators for telegraphic purposes.

FRANCE.

CLASS 13.

Hardy, E., Paris.—Electro-dynamic apparatus.

Bonis, P. F., Paris.—Wire for electric conduction.

Bilores, A., Paris.—Wire for electric conduction.

Prudhomme, P. D., Paris.—Electric bells and signals.

Breguet, L. C. F., Paris.—Philosophical instruments, and electric telegraph apparatus.

Digney, Brothers, and Co., Paris.—Telegraphic apparatus.

Rattier and Co., Paris.—Submarine telegraph cables.

Thomson, W., Paris.—Telegraphic instruments.

Serrin, V. L. M., Paris.—Regulators of electric light.

Mouilleron-Vinay, Paris.—Electric telegraph requisites.

Dujardin, Lille (Nord).—Telegraph instruments.

Moreau, Batignolles, Paris.—Electro-medical apparatus.

Guyot, d'Arlincourt, Paris.—Printing telegraph.

Largefeuille, Châlons, Upper Saône (Saône and Loire).—Telegraphic apparatus.

Sortais, Lizieur (Calvados).—Improved telegraph instruments.

CLASS 5.

Orchard, A., Paris.—Mode of firing by electricity.

CLASS 7.

Lethuillier, Pinel, P. F., Rouen (Seine Inf).—Magnetic indicators of the level of water in boilers.

Berlioz and Co., Paris.—Magneto-electric machine.

AUSTRIA.

CLASS 13.

Haas, C. and Co., Gratz.—Specimens of electrotyping, &c.

Marcus, S., Vienna Neuba, 318.—Telegraph instruments, &c.

Nuss, A. and Gullitzer, T., Pesth, blaue Hahngasse, 12, and Elizabethplatz, 4.—Improved Morse-telegraph apparatus.

Seyss, L., Atzgersdorf, near Vienna.—Bell signal apparatus, &c.

Siemens and Halske, Vienna, Erdberg, 46.—Telegraph apparatus, &c.

States Railway Society, I. R., Vienna.—System of telegraph without batteries at intermediate stations: drawing and description.

Telegraph Direction, I. R., Vienna.—Morse apparatus, with electromotor, telegraph maps of Austria.

BAVARIA.

CLASS 13.

Rodler, A., Nuremberg.—Carbon cylinders for electro-galvanic apparatuses.

PRUSSIA.

CLASS 13.

Gressler, J. and Co., 34, König Str., Berlin.—Galvanic apparatus.

Siemens and Halske, 94, Markgrafen Str., Berlin.—Telegraphic apparatus, voltaic inductors, &c.

DUCHY OF SAXE-COBURG GOTHA.

CLASS 13.

Ausfield, H., Gotha.—Electro-magnetical apparatus, &c.

ITALY.

CLASS 13.

Bandieri, G., Naples.—Electro-dynamic apparatus, &c.

CLASS 5.

Vincenzi, E., Modena.—Model of an electric signal to prevent the collision of railway trains.

CLASS 7.

Bonelli, Cav. G., Turin.—Electric loom, for weaving any kind of material.

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THE NETHERLANDS.

Class 13.

Bekking, J. A. M., Rotterdam.—Induction machines.
Benoist, J., Heerenveen.—Printing telegraph.
Spanje, T. van., Tiel.—Electro-magnetic clock, with commutator, &c.
Van Wetteren, Brothers, Haarlem.—Magneto-electric machine, &c.

Class 4.

Clercq, H. de, Haarlem.—Gutta percha: collection, illustrative of its applications.

SWITZERLAND.

Class 13.

Atelier des Télégraphes Suisses, Berne.—Several systems of telegraphic apparatus, electric writing chronograph, &c.
Hipp, M., Neufchâtel.—Telegraphic apparatus, electric clocks, regulators.

WIRE GUAGES.

We are favoured by Captain Schaw, R.E., with the subjoined table, drawn up by him from the most reliable information that could be procured. It will be found that it differs from the tables already inserted in this journal, namely, those given by Messrs. Ryland, Cocker, and Preece. It is extremely desirable that a definite guage should be fixed upon and adhered to in telegraphy, and we will endeavour to arrive at that which it is most expedient to adopt.

Mr. Willoughby Smith, states that the Gutta Percha Company had for a time considerable difficulty in consequence of the diversity of guages adopted by wire-drawers. The company now insist upon the adoption by those by whom they are supplied, of "Cocker's Guage," and so avoid the difficulty. At the Government telegraph experiments, the "guage measurements" were dispensed with; the diameter of the wires, &c., being taken by the means of a graduated calliper. A formula, given below, for arriving at the true diameter of copper wires appears in page 177 of the Electrician.

Number on B. W. Gauge.	Diameter in inches.		Weight in lbs. per 100 yards.	Breaking strain in lbs.
000			149·33	
00			110·32	9040
0			88·31	7280
1	15-48ths	·3125	68·75	5650
2	14-48	·2927	59·90	4930
3	13-48	·2708	51·56	4250
4	12-48	·25	44·00	3620
5	11-48	·2291	37·00	3040
6	10-48	·2084	30·56	2500
7	9-48	·2075	26·15	2200
8	11-64	·1718	22·10	1840
9	10-64	·1562	18·36	1560
10	9-64	·1406	14·97	1280
11	8-64	·125	11·95	1000
12	9-80	·1125	9·24	800
13	8-80	·1	7·05	568
14	7-80	·0875	5·50	456
15	6-80	·075	4·29	352
16	1-16	·0625	3·22	264
17	11-192	·0572	2·48	208
18	10-192	·0521	1·91	160
19	9-192	·0468	1·55	128
20	8-192	·0416	1·22	104
21	7-192	·0364	·934	79·5
22	10-320	·0312	·687	58·5
23	9-320	·0281		
24	8-320	·025	·478	
25	11-480	·0229		
26	10-480	·0208	·321	
27	9-480	·0187		
28	8-480	·0166		
29	7-480	·0146		
30	6-48	·0125		

The weights and breaking strains were obtained from Messrs. Johnson, wire-drawers, of Manchester.

N.B.—The relation between the diameter and weight of copper wire is expressed by the formula—

$d = \frac{1}{4}\sqrt{\frac{w}{L}}$ Where d = diameter in inches.
L = length in inches.
w = weight in ounces avoirdupois,

whence the weight of one yard in lbs. $= qd^2$.

The Student.

For many purposes of experiment a galvanometer is required which will render evident very feeble currents of electricity, generated in many instances by other means than the voltaic battery. The galvanometer we have figured at page 58, vol. 1, is adapted only for the indication of a current of comparatively great quantity traversing the instrument. The copper strip here passes but once over, and twice under, the magnetized needle, our object being to avoid a degree of sensitiveness which would cause the needle, in almost every case when testing various forms of the voltaic couple, to be deflected to nearly its utmost limit. We may now endeavour to increase the sensitiveness as far as possible; and the first means at our command is to increase the number of convolutions of conductor so as to form a coil inclosing the needle. It is generally assumed that in proportion to the number of convolutions of insulated wire will the delicacy of the instrument be increased; but this is by no means absolutely the case, for, in increasing the length of the wire, we augment the resistance of the circuit to be traversed by the current, and consequently, as we have seen, we may diminish the quantity of electricity which otherwise might be set in motion. Again, as in the electro-magnet, the effect of that portion of the wire which is most distant from the centre of action may be considerably diminished when a very long length has been coiled, and this is especially the case when a wire of moderate diameter is employed, so that the resistance of the galvanometer may not be very great. In many galvanometers of recent construction an enormous length of wire has been employed, while other means of increasing the sensitiveness have been neglected. But in the instrument employed by M. Dubois Reymond in his researches in electro-physiology, which was constructed upon the most approved principles, the number of convolutions of wire amounted to between 25,000 and 30,000. For our own part, we have found 80 or 120 turns of wire, No. 30 or 36 guage, sufficient for all general purposes of experiment when proper attention is paid to other conditions upon which the sensitiveness of a galvanometer depends.

The suspension of the needle by a fine hair, or better, by a single fibre of cocoon silk, affords a mechanical means of increasing the sensibility of the galvanometer, which, for delicate instruments, should be employed in preference to any mode of pivotting the needle. The fibre may be attached at its upper extremity to a screw, which allows the needle to rest upon the graduated card beneath, when the instrument is moved or put aside, and which raises it when the galvanometer is to be used. A short piece of straw, into which the thread is cemented, and which moves vertically in another piece of straw or a small glass tube fixed vertically in the top of the glass shade or in the wooden or cardboard cover of a glass cylinder covering the instrument, answers the same purpose very well. A fine piece of straw also allows of a convenient and accurate mode of suspending the magnitised needle. The latter is passed through the straw transversely, so that it may accurately assume the horizontal direction, and the lower extremity of the suspending fibre is cemented into one of the ends of the straw. A small pin passing upwards from the base of the instrument into the lower portion of the suspended straw, prevents any excessive oscillation of the centre of suspension.

An instrument of moderate sensitiveness may be constructed by simply suspending the needle *over* a longitudinal coil of wire, the ends of which communicate with binding screws or mercury cups. A power more than double is, however, obtained by suspending it within the coil by means of an aperture in the central portion of the latter, through which passes the suspending thread. In this case an indicating needle attached to the same axis as the magnetic needle is required to indicate the movement of the latter on the graduated card placed above the coil. The indicating needle should be as light as possible, and, of course, perfectly parallel to, or else at right angles to, the magnetic needle. It may be made of a glass thread, a piece of split straw, or a fine wire passing through the straw to which the magnetic needle is attached at a distance above the latter, equal to rather more than half the height of the coil. We will now show that, where a very sensitive instrument is required, the indicating needle may with great advantage be replaced by a second magnetic needle above the longitudinal coil of wire.

It is desirable to bear in mind the direction in which the magnetic needle is deflected by the passage of a current of electricity along a conductor. If a conducting wire be placed over a horizontal needle the pole of the latter, which is in the direction of the positive element of the battery, moves to the westward; if the same wire be placed beneath the needle the same pole moves to the east. If, then, two wires from separate batteries, of equal power, are placed at equal dis-

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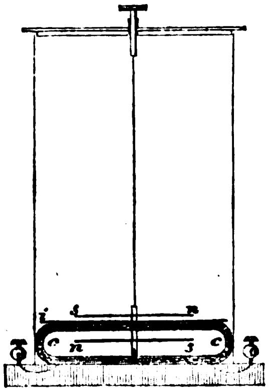
tances, one above and the other beneath the needle, the latter will remain stationary, providing the two currents are passing in the same direction. But if one of the wires be bent so as to enclose the needle, the direction of the current, in regard to the latter, will be in one direction above and in the contrary direction below the needle, which will be deflected with twice the force due to the wire passing simply either above or below. Now, if we attach to the axis of a needle enclosed within a coil a second magnetized needle above the coil, and with its poles disposed in similar manner, it is easy to perceive that we shall decrease, by about one-half, the sensitiveness of the instrument. But if the poles of the second needle be placed in a contrary direction to those of the first, we may expect that the sensitiveness will be increased by one-half. We find, however, that the delicacy of the instrument has been improved to a far greater extent, and that we have in fact a new instrument surpassing every other arrangement we could adopt.

The reason of this is, that we have neutralized to a very great extent the divertive influence of the earth's magnetism, *i. e.*, the force which is to be counteracted by the influence of the current traversing the wire. It might be thought that the same object would be attained by employing a needle, or needles, of very feeble magnetic power. But the contrary is the case, the more powerfully the needle is magnetized the greater is the action of the current in producing its deflection, or, in other words, the effect of the current increases in greater ratio than the influence of the earth's magnetism. By employing two needles magnetized as far as possible to saturation, we obtain, if the two needles be exactly equal in power, a true *astatic* compound needle; that is, a needle in which the directive force of the earth's magnetism is completely neutralized, and which, consequently, has *no* direction of its own, and is absolutely free to obey the influence of the current. But, in practice, it is impossible to obtain two needles exactly equal in power, and the so-called astatic needle, if properly suspended, consequently points north and south. If the astatic needle were suspended within the coil, it would not be perceptibly deflected by the passage of the current; but, by arranging it with the lower needle within, and the upper needle above the coil, we obtain a deflection due to the sum of the actions upon the two needles, and to the absence of the counteracting directive force of the earth.

This beautiful instrument, the *astatic galvanometer*, may readily be constructed by the student, or amateur, who is willing to devote a certain amount of time and attention to the attainment in the same of a comparative degree of perfection. The following cut represents in section a simple form of the instrument.



The wire, which is best insulated with silk, may simply be wound upon a cylinder about 1½ inch in diameter, and the circular coil when removed elongated with the fingers and bound with silk thread. It may then be cemented to a sole, or stand, as at *c*, and the terminals attached to two binding screws, or mercury cups, so as to insure metallic contact. Through the upper and central portion of the coil a small piece of fine glass tubing may be introduced to allow of the free passage of the straw through which the two magnetic needles are passed. Immediately over the coil is attached a graduated circle, through which is drawn a line parallel to the centre of, and corresponding with the middle portion of the coil. Over this line the needle remains when at rest. The deflections are usually measured upon a graduated arc of 90° on either side of the extremities of the median line. The instrument is surrounded with a glass cylinder, to which is fitted a wooden or card-board cover with a central aperture through which passes the rod or screw which serves to raise or lower the needles. The construction of the instrument in its simplest form will probably be sufficiently understood from the foregoing. To those who may desire to purchase an instrument of the most perfect construction, we recommend those now manufactured by Messrs. Elliott, which are adapted for the most delicate electrical experiments.

THE "TIMES" AND SUBMARINE TELEGRAPHY.

To the Editor of THE ELECTRICIAN.

SIR,—The following letter having appeared in the *Times* on the 1st inst., a note was addressed to the editor, which also is appended, but despite of the claims of the question to be considered *pro.* and *con.*, no notice was taken of the query.

A PRACTICAL TELEGRAPHIST.

ATLANTIC TELEGRAPHS.

[From the TIMES.]

SIR,—Your recent article on the two routes proposed for a telegraph to America has excited so much discussion among those who are interested in the subject, and has drawn so much attention to the difficulties of a practical solution of the question, that I am induced to offer some suggestions derived from the experience gained in submarine telegraphy during the last few years.

In 1856, when a company was organized to lay a line by the direct route from Ireland to Newfoundland, nothing whatever was known about long deep-sea telegraph cables, and the temporary success which attended the efforts made on that occasion proved greater than was to have been expected from the untried nature of the experiment. The facts which this initiatory trial leave to us are of such vital importance in the prosecution of any further submarine line to America, strengthened as they are by later experience, that no one should blindly rush upon an enterprise embarrassed with so many physical obstacles, until we have some better mode than is yet known of dealing with them.

Experiments at a cost of £400,000 cannot be continued, and if financial support is to be expected from the mercantile world, it will be necessary to convince them that cables of 2,000 miles in length can be safely laid, and are not likely to break down within a very limited number of months or years; and, further, that a sufficient number of messages can be got through them to render the outlay of capital remunerative. I need scarcely state that the first operation must always be attended with a certain degree of risk. The second point—viz., the preservation of cables—has lately attracted much attention, and hopes are expressed that recent experiments may have beneficial results. The question, however, of the number of messages that can be passed through a wire during a given time is so all-important that it may be interesting to deal with it in detail.

In July, 1857, when the Atlantic cable was completed, or nearly so, the directors published a narrative of the undertaking, in which they quoted Professor Morse's opinion that ten words a minute could be telegraphed through the wire from Ireland to Newfoundland. After the line was actually laid the greatest working rate was one word and a-half per minute, and the additional battery powers added, in order to increase the speed when the line was about to be opened to the public, led to its breaking down altogether.

The Malta and Alexandria line of 1,300 miles recently laid for the Government was wisely divided into three short sections, with intermediate stations at Bengazi and Tripoli. Through the entire cable, when connected in a single circuit, only three to four words per minute could be telegraphed, while through the divided sections* a speed of ten words a minute can be attained.

It is, however, stated that if a new Atlantic line be laid, one patentee has promised ten words a minute, another sixteen, and so on.

No doubt daring electrical enthusiasts and aspirants for office will promise twenty words a minute, and we shall hear of instruments and inventions of fabulous power without number, which are to surmount all difficulties; but I venture to think, that as we have positive proof that a line of 1,300 miles will only produce three to four words a minute, it is impossible to resist the conclusion that a direct Atlantic cable, one-third longer, will again only be capable of carrying messages at the rate of one word and a-half per minute, or thereabouts.

Under such circumstances I would therefore venture to submit that sufficient experience has not yet been acquired to justify a large outlay in an undertaking which, although nationally desirable, affords little promise of commercial success.—I am, sir, yours, &c.,

ANGLO-AMERICANUS.

AN ATLANTIC TELEGRAPH.

To the Editor of THE "TIMES."

SIR,—Your correspondent, "Anglo-Americanus," would greatly benefit the profession of electro-telegraphy if he were to inform us where any published *experiments* are to be found in verification of his statement respecting the law of retardation of signals in submarine cables. I have witnessed myself some hundreds of carefully-conducted experiments with a view of ascertaining that law, and the results obtained were, certainly not in conformity with the "law" of the squares of the distances.

A PRACTICAL ELECTRICIAN.

* Query "through *each* of the divided circuits."

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PRICES CURRENT OF INSULATING MATERIALS.

GUTTA PERCHA.

A few small parcels of the late arrivals have been brought forward at public sale and realized very high prices.

Genuine, mixed	2s. 2d. per lb.
„ very mixed, with some little good	1s. 7d. „
Inferior reboiled	1s. 5d. „

INDIA RUBBER.

A very inactive market, but the importers are very firm.

Fine Para	2s. 2d. per lb.
Negro Head	1s. 1d. to 1s. 3d. per lb.
Java	1s. 5d. to 1s. 6d. „

May 8, 1862.

WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	——
20	Do. B 7 per cent. till 1862 .	all	18 to 20	——
20	Do. C. „ „	all	9 to 11	——
10	Channel Islands Telegraph .	all	——	——
Stock	Electric Telegraph . .	100	98 to 101	——
25	Do. New	15	— dis.	——
5	London District Telegraph .	4½	3¾ to 8¼ dis.	——
10	Mediterranean Extension Tel.	all	8½ to 4½	——
10	Do. 8 per cent. pref. . .	all	——	——
20	Red Sea and India Telegraph	all	19 to 19¼	——
1	Submarine Telegraph, scrip.	all	8/8 to ⅝	——
1	Do. registered . . .	all	8/8 to ⅝	——
10	Do. „ . . .	all	4 to 6	——
2	Telegraph to India . .	1	⅓ dis. ⅛ pm.	——
5	United Kingdom Telegraph .	2¾	1½ to 0½ dis.	——

Telegraphic News.

EGYPT.

THE defect in the northern section of the old Red Sea cable, owing to which our telegraphic communication with Jubal has been intercepted during the past fortnight, it is ascertained, exists within a very short distance from Suez. A steamer has been prepared for the purpose of underrunning the cable, and there is every reason to hope that the damage will very soon be made good; but it seems equally if not more certain that the line, even as a temporary resource, cannot be depended upon. The perfect success of the Malta and Alexandria cable forms a pleasant contrast with the unhappy fate of its predecessor in the Red Sea. Its working capabilities seem everything that could be desired, and the work upon it has never been subjected to the slightest interruption. The Jubal line was stopped at the time of the transit of the last Calcutta mail, but through the delay in the arrival of the Marseilles steamer at Alexandria, in consequence of bad weather, all the telegrams for India arrived in time to be posted at Suez.—*Times.*

TELEGRAPH BETWEEN RANGOON AND SINGAPORE.

FOR the purpose of establishing a telegraph line between Rangoon and Singapore, in order to connect and materially shorten the present system of telegraph communication with India, China, and Australia, a company has been formed and wish to obtain a subsidy from Government. A letter from Mr. F. Gisborne, relative to this subject, was read at the meeting of the Liverpool Chamber of Commerce yesterday, and the council decided to memorialize Government in favour of the scheme.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

TUNNEL SIGNALS.

To the Editor of THE ELECTRICIAN.

SIR,—I have been anxiously watching the progress of the correspondence on railway tunnel signalling, in the hope that something would result, of advantage to railway management. Your correspondent, "Inquisitive," in his first letter, led us to expect much, and I certainly looked for something new, if not startling, from him. But I am afraid it is the old tale of the mountain in labour, and it has brought forth—what? A Tyer's signal instrument, and a Bright's bell telegraph. In the first there is nothing new, as it is known to all telegraphists of any experience. The second he gives us without any originality, inasmuch as he omits to tell us how the bell telegraph is to be adapted to railway tunnel signalling; and in this consists the essence of the idea, if it is worth anything at all. Though he recommends its adoption in No. 22, he acknowledges in No. 25, that he "agrees with Mr. Newman, that alarums should not be required to give intelligible signals;" albeit, Bright's telegraph is an alarum in principle. It is an undisputed fact that signals, which appeal to the eye or ear for a moment, cannot be trusted; and I cannot see what advantage Bright's bell telegraph offers, to induce your correspondent to recommend it for tunnel purposes.

Tyer's system, which is also recommended, I have a high opinion of as being far superior to the unsafe system now in use; but, though Tyer's is a good system, Clark's is better, and I give this opinion as the result of my experience in train signalling.

I do not wish to enter on the advantages of Clark's system, because you have already promised to give extracts from his pamphlet; but I wish to put your readers right on one or two points, where a misconception would arise from the statements of your correspondent.

After strongly recommending Tyer's system, he neutralizes his eulogiums by acknowledging, that it "will not act where there are sidings at the end of a tunnel." Why, this is just the time and circumstances when the system is most required to act; and if "Inquisitor's" statement was really true, the system would be utterly worthless; but, on referring to No. 11 of the code of instruction, issued by the patentee for working his instruments, I find the following:—"In the event of any obstruction happening on the line, the signal—*down train on line*, or *up train on line*, as the case may be, is immediately to be signalled, accompanied with five distinct beats "on the bell or gong."

No. 12 provides for this signal being properly acknowledged by the receiving station, who stops all trains till line is signalled clear again.

As one of the advantages of Tyer's system, he says, that in the event of the circuit being interrupted, the time system is at once adopted. This I take as an advantage on the wrong side. Your correspondent would know, if ever he was at a railway accident, that, in nine cases out of ten, the posts and wires come in for their share of the consequences, and help to make the wreck complete; would he, in consequence of this interruption to the wire, at once adopt the time system, and, after the lapse of a few minutes, send another train headlong into the ruins of the first? Where is the advantage of that? But, may I ask, who is responsible for this regulation? Not Mr. Tyer; for in the elaborate regulations already quoted there is no such order; nor, indeed, is there any provision made for meeting the emergency of an interruption to the circuit.

As a further advantage, "Inquisitive" states the system is worked with one wire. I will grant him this advantage on the score of economy; but on the score of efficiency this is its greatest defect. A gong, a bell (both giving "intelligible signals"), and two sets of indicators (worked by opposite end of tunnel) are worked through one wire. Now, though it is probable that the wires would not, by a coincidence, signal to each other at the same instant, once in a thousand times; yet, at that thousandth time, it must produce confusion of signals that brought about the Clayton tunnel accident; and it would only require in this thousandth time the remaining collateral circumstances, viz., three heavy trains following closely upon each other to produce a similar disaster.

Of Mr. Clark's system, "Inquisitive" plainly shows in his correspondence that he knows nothing, excepting that it requires three wires to work it; and in the face of this it is too much for him to boldly assert, that it is "not a plan to guard a tunnel." But I will leave it to your extracts to put him right on a matter in which he is as far "at sea" as it is possible to be at present.—I am sir, yours respectfully, "LEENA."

TUNNEL TELEGRAPHS.

To the Editor of THE ELECTRICIAN.

SIR,—I am sorry to find from your impression of the 25th ult., that your correspondent, "Inquisitive," has been unable to understand my explanation of Clark's train signalling system; as, however, you have promised to publish extracts from Mr. Edwin Clark's pamphlet, "Inquisitive," will have an opportunity of making himself more fully acquainted with the system in question.

"Inquisitive" very strongly advocates Tyer's system of train signalling, consisting of one wire only. Clark's system (as I have previously explained) consists of three distinct wires—one for the "down line," one for the "up line," and one for the "bell." With respect to Tyer's (as "Inquisitive" states), if the line wire be broken there is "no connection whatever" between the two distant stations, but not so with Clark's. If the bell wire be broken, you have still two "distinct telegraphs," one for the up line, one for the down line." Or if one of the line wires, instead of the bell wire be broken, you have then a single line telegraph and a bell. Whether such means of signalling would be preferable to "Inquisitive's" "no telegraph at all," or which of the two systems (Tyer's or Clark's) is the most effective, I leave your readers to decide.

The bells referred to in my former letter, "requiring no winding up," are employed at signal and other stations.—I am, sir, yours obediently,

1st May, 1862. T. C. J.

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VOLTAIC BATTERIES.

To the Editor of THE ELECTRICIAN.

SIR,—Would you be so kind as to inform me of a suitable and cheap battery for experiments in electro-magnetism? I had read that Smee's is well adapted for that purpose, and I procured four cells, each holding one pint, but the price charged was 7s. 6d. per cell; now, a large battery on this principle must cost a good deal. I have never used any other battery but this, and the common zinc and copper plates, I should be truly thankful to you could you recommend me any cheaper battery. I should have tried Bunsen's some time since, but was deterred on account of the acid vapours. I am told that the platinized plate in Smee's does not last in working order long, is this the case? If you would answer these questions I should be very much obliged.—Your obedient servant,

T. H. K.

DEFLECTION OF THE VERTICAL NEEDLE.

To the Editor of THE ELECTRICIAN.

SIR,—In answer to your correspondent, "L. L. S.," you were quite right in assigning the dip of the magnetic vertical needle on one side only to imperfect hanging or pointing, which must be corrected by grinding the needle or drawing the axle; in balancing needles I find it necessary to make them stand vertical in two positions, say, for instance, facing north and south, then, when the instrument is moved round to face the east it ought to go over the same distance from zero on one side that it does on the other side of zero when facing the west. The more delicate the needle the greater will be the dip or the influence of terrestrial magnetism on it. I have made some that have dipped as much as 30° on each side, but there is great nicety required in the pivots when so delicate, or the needle will not drop well to zero. I find for general purposes a detector that will dip about 10° on either side about the best.—I am, &c. THOS. BRITTAN.

157, *Pentonville Road.*

TECHNICAL AND SCIENTIFIC TERMS.

To the Editor of THE ELECTRICIAN.

SIR,—To coin new words, reconstruct old ones, and re-adapt the same as the expressive embodiments of novel ideas and phenomena, is the peculiar prerogative of all new sciences; nor is electrical science any exception to the rule; and yet this one circumstance tends as much, if not more than any other cause, to the retardation of the advancement of that series of discoveries which in part constitute the special science which thus calls its obstruction into existence. And this for the simple reason, that, with the exception of the privileged few who have been initiated into all the known mysteries of the science, the study of which is the all-absorbing purpose of their lives, it is practically a sealed book from the fact that the words new, reconstructed, and re-adapted, in use among its devotees as the exponents of peculiar ideas and phenomena remain unexplained, or if an explanation is attempted, confusion is rendered more confounded, either from the inefficient way in which it is done, or from the mass of inexplicable verbiage used, by way, I presume, of showing off the explanator's thorough mastery of the subject. The exploit is clever, doubtless, but by no means satisfactory. A skilled orator may, unquestionably, thrill his audience with an oration, one word of which shall not be comprehended nor understood by them since it is delivered in an unknown tongue; it is an agreeable treat, but uninstructive. As much, however, cannot be said of the person who makes the explanation of abstruse words and phrases an occasion for parading his own supremely eminent abilities of conclomerating mystification, for then there is neither amusement nor instruction. But the hapless reader who wades through his lengthy paragraphs ends with his mouth open, and his whole being reduced to one bewildered stare!

And still, as the science progresses new discoveries are made, other phenomena are observed, which necessitates the manufacture of an increasing number of other new words, and the re-application of existing forms of speech to suit circumstances, objects, and emergencies perpetually occurring, and these are manufactured, appropriated, twisted, and tortured from their original meanings by the parties requiring them, with a recklessness which nearly proves they have not the fear of any lexicographer before their eyes. The shade of Johnson would be horrified to hear the application of words, the meaning of which he had settled so arbitrarily and dogmatically when in the flesh.

And matters are not mended by gentlemen otherwise eminent in electrical and telegraphic science, and from whom we have a right to expect better things than we get; but doctors will disagree, and there is unfortunately no limit to the ramification of their disagreements; and hence we find that the disagreements which begin in one asserting the existence of certain phenomena, the developments of which have certain results; a second denying the alleged results while admitting the premises on which they are grounded; a third rejecting both, and proving satisfactorily (to himself at least), that the whole phenomena, and everything therewith connected, are something else of quite an opposite character; while a fourth repudiates the entire series in toto, extends itself even to the appelatory regions; there is no unanimity even in so simple a matter as the naming of phenomena and their results. Of a truth, it is quite time some one set up as an electrical and telegraphic nomenclator.

If A call bread, bread, we do not expect B to call it butter, nor C cheese; nor should we thank D to comprehend in one appellation, bread, butter, biscuits, bacon, and barley-flour; and if it be so necessary in the common affairs of life to be clear, definite, and precise in our nomenclature, how much greater is the necessity in sciences which are necessarily abstruse and difficult to be understood, even when set forth in the clearest and most definite language possible?

As the able and recognized organ of telegraphy, THE ELECTRICIAN should assume, without scruple, the office of nomenclator and explanator. Not the least important of its duties should be to settle disputable terms; call new phenomena as they appear, and the results of such phenomena, by apt and appropriate names, regardless of any who think themselves have a greater claim to the reputation of electrical linguists; let a small portion of its space be devoted also to the explanation and illustration in a popular form of such words that are in constant use among electricians, and which are not subjects of dispute; by this means the science may be rendered attractive, and easy to be understood; its students may be increased in number, and the more popular the science becomes the greater will be the sale of THE ELECTRICIAN—a consideration which, I suppose, according to the cant phrase of the day, we must term one of the lowest; nevertheless, low or high, we cannot well pull through in any matter without "the sinews of war," and I presume that neither the editor nor the publisher of THE ELECTRICIAN would have any objection to see its already large circulation doubled.

The obscure and recondite language which characterizes scientific writing presents an insurmountable obstacle to the tyro; the apt illustrations of the pursuit of knowledge under difficulties are but few, the exceptions, in fact, to the almost universal rule, that the bulk of humanity will rather go back than attempt to scale the mountain that obstructs their path, although it may be no more than a magnificent molehill; but the pioneers of science should obviously do something towards removing these obstructions, and not themselves be justly liable to the charge of creating the mountains which bewilder and scare the timid, and retard the progress of those who are not. Of course, the naturally indolent create their own difficulties, they never get beyond the A B C of anything; but between this low strata and the high one above-mentioned, runs an intermediate class, who, while having an ardent desire of obtaining knowledge, are yet easily intimidated. Surely it were worth while to attempt the adaptation of your instructions to their capacities of taking in the same, and certainly a most important step in this direction is to settle definitively the meanings of words and phrases.

And, to recur to a matter before hinted at, how desirable it is to avoid all unnecessary flourish in writing scientific articles, since it does but serve to cloak the meaning with an impenetrable mass of obscuration and ambiguity; while, on the other hand, it is equally desirable to avoid that paucity and barrenness of expression which hinders the most persevering of readers from attempting the second paragraph, supposing they manage to get through the first, and if a writer do not secure the attention of his reader, of what avail is it?

I do not for a moment suppose that any man deliberately writes an article with the express intention of producing a mesmeric effect upon his readers; and yet I have met with articles in THE ELECTRICIAN as effectively soporific as the celebrated Professor Schlumpfghens' learned disquisition:—"On the impalpability of moonshine, and how far it enters into the composition of disembodied spirits." And yet I do not require to lapse into the arms of Morpheus by such a method, since Nature is exceedingly kind to me in this respect, at proper seasons.

But I must conclude, lest I fall into some error. I trust to be pardoned for my freedom in thus writing upon such a subject, and hope the Editor of THE ELECTRICIAN will take the initiative in the above matters, and thus increase the debt of gratitude his readers already owe to him for the ever-ready, valuable information which is from week to week vouchsafed in its pages.—Yours obediently, NOMEN.

[We have already stated to one of our correspondents that we shall be happy to explain the meaning and ordinary application of technical or scientific terms which may appear obscure to any of our readers, providing they will point out to us the expressions in question.—ED. E.]

TESTING IN VACUO AND UNDER HYDRAULIC PRESSURE.

To the Editor of THE ELECTRICIAN.

SIR—The testing of cables in the course of manufacture is, undoubtedly, a subject of great importance, and should be conducted with great care on the part of those entrusted with the duty. The fearful ordeal through which the poor Atlantic cable had to pass amongst conflicting theories which resulted in its partial destruction before it was ever laid down, should not be lost sight of. The Malta and Alexandria cable had also to undergo the huge farce of being tested in vacuo and under pressure—the latter being a condition, as proved by experiment, admirably adapted for the concealment of faults. The Wexford cable, recently submerged, escaped the infliction, and so I believe will the Zandvoort cable now in course of construction, but I am informed that the St. David and Queenstown is to undergo the operation. Is it not a pity, sir, that the success of submarine telegraphy should be thus thwarted by patents originated by ignorance and applied by incapacity? A TELEGRAPHIST.

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GUTTA PERCHA AND INDIA RUBBER INSULATION.

To the Editor of THE ELECTRICIAN.

SIR,—In reading the various speeches made some short time since at a telegraphic *soirée* given by Mr. Samuel Gurney, I was much surprised that no allusion was made to the article of india rubber as an insulator; surely the persons there assembled knew something about the latter article, but perhaps not much, as it was stated by one of the gentlemen that gutta percha is the only article at present used for telegraphic purposes; but, sir, the other day I was rather inquisitive in noticing that the bundle of wires protruding from the door of one of the iron posts in the street were gutta percha, but all the joints were being covered with tape caoutchouc, I thought it exceedingly strange, and I must leave some of your correspondents to explain why it requires india rubber to be placed over the joints to protect the gutta percha, as if these precautions are necessary for street purposes, surely much greater care must be required for submarine.

There no doubt has been a very large outlay in improving gutta percha by giving it the smooth appearance of glass, but this surface improvement is of very trifling import, when a magnifier is used it is easy to obtain a correct view of the impurities generally. This gum, with all that can be said for it, is very far from clean or pure, the qualities of 1862 and that first imported bears no improvement, if any difference, the adverse is the rule; but not so with india rubber, as the very commonest sorts can be cleaned, and the best proofs we have of this is to be seen at the corner of every street in those fancy-coloured balls, and I would advise any who have the slightest idea of the porosity of caoutchouc to purchase one of those toys for the practical purpose of testing the absurd notions that some would try and have us believe. The pressure used in the manipulation of gutta percha which produces the smooth surface, before alluded to, is really nothing more or less than producing a crust which, when broken, leaves those parts extremely liable to immediate destruction, but how different would this be if there was elasticity in this gum, as in caoutchouc, the importance of this cannot be overlooked, as in cables of great length it is so much required to render success to the great undertakings yet to be accomplished.

In conclusion, sir, it must be very desirable to maintain facts, and rest assured that time alone is required to overcome every obstacle to the adoption of the best article.—I am, sir, yours obediently,

CITIZEN.

To the Editor of THE ELECTRICIAN.

SIR,—I have been so occupied during the past month that I have scarcely had time to take the smallest possible dip into the pages of THE ELECTRICIAN, which, I must own, has been a great privation, since I look forward to every forthcoming number with as much interest, and devour it with as much zest, as does a boarding-school miss the third volume of a fashionable novel. I find, however, in the number, April 11th, that "P. Q." expresses his probable intention of withdrawing from the discussion in which he and I were engaged relative to the comparative merits of gutta percha and india rubber as insulators, and he will do wisely to adhere to his resolution, since his ground is scarcely tenable. Neither do I wish to continue this discussion if no good is to result from it, or if the numerous readers of THE ELECTRICIAN are weary of it. But I may be allowed to say that I could have wished "P. Q." had withdrawn himself from it with a better grace, and with a little more courtesy. I have none but friendly feelings towards him, and should much regret if I thought that anything I had written should have given him just cause for the slightest passing animosity. But my conscience exonerates me from all that, as I am not aware of having written anything that should have provoked an uncharitable expression; but I can extend the hand of friendship for all that, secure of a hearty shake in return, as far as such matters can be performed by mere shadows.

6th May, 1862. MOMUS.

Miscellanea.

THE CONSTRUCTION OF TELEGRAPH CABLES.—An elderly lady bought a Turkey carpet, not to be too roughly visited by the winds of heaven or the feet of the profane. So she covered it carefully with an Indian mat. But this, too, was too good to be ill-used; so she finally applied a brown holland over both. So it is with a telegraph cable. We first construct the two essential parts—the conductor and the insulator. Then we set to work to combat a shadow. We ignore the reduced specific gravity, and treat the wire as if it alone were to be suspended in water. Under this impression we construct an outer system of wires, enveloping the cable as in the arms of death. These again we are now covering with an insulating material, and it is probable that we shall perceive that the latter will also require to be protected by something else. Unfortunately, in this case, the expense of the brown holland is greater than the Turkey carpet.—*Capt. Selwyn "On the Use of Cylinders in laying Submarine Cables."*

IT is curiously illustrative of the economy of nature, that the sharp points of the vegetable kingdom are more powerfully attractive of electricity than the sharpest point of metal that can be made by man's ingenuity; for if a piece of pointed iron and a blade of grass be held near to a prime conductor, so that each point becomes luminous, and then gradually be drawn back, the iron will lose its luminosity long before the point of the grass. The sensitiveness of the point of a blade of grass may be seen in any part of an apartment where electricity is being evolved. Instances have been observed in green-houses where two pointed-leaved plants have covered another plant, and drawn from the air all the adjacent electricity, by which the more humble and less prickly plant in the shade has perished, solely from want of this vital principle. This is another instance of the singularly careful arrangement of the entire mechanism of nature, in which the film is but clearing off man's mental eyes to its simplicity, beauty, and divine origin.—*"Elements of Natural Philosophy," by Jabez Hogg.*

MR. J. W. WATSON succeeded in producing the electric light at a smaller cost than any previous inventor. The great economy of his patent process consists in making the battery available for other chemical purposes; viz., that of forming valuable pigments for use in the arts. In all galvanic batteries at present employed, nothing but electricity was gained on the profit side—all else was loss. The products were, commercially speaking, worthless. Generally, electricians contented themselves with using the common mineral acids and the minerals in use since Volta's discovery; but Mr. Watson has sought to introduce some of the rarer metals, the products of the decomposition of which would cover their expense. In those experiments, however, he was not rewarded with the desired success, and had therefore turned his attention to the discovery of new exciting agents, or electrolytes; and in this he was satisfied that if he had not accomplished all, he had at least made such progress towards improvement as would materially benefit the commercial world. Electrical illumination was now possible, and it was to be hoped that before long the splendid light afforded by the voltaic battery would be ranked among the common things of life. The batteries were termed, from the nature of their products, the chromatic batteries. It might appear difficult to those unacquainted with chemistry, how any number of galvanic arrangements could be made to produce a variety of colours. But the real number of natural colours was small, and the difference of a single shade imparted to each a distinct commercial existence as a colour. By the use of a few substances introduced into five batteries, they were able to produce no less than 100 valuable pigments, transcending by an immense percentage the original value of the articles from which they were produced. The colours are formed, not by any subsequent mixing of the products of the batteries, but are the result of the actual development of the electricity in the battery; and the materials employed aided the galvanic effect by giving "constancy" to the machine, a result of the most vital importance. The manner of working the battery is shortly this —The cast-iron and zinc battery (invented by the Rev. N. J. Callan, of Maynooth, and commonly called the Maynooth battery), when worked by sulphuric acid, produced sulphate of iron and sulphate of zinc, which were comparatively worthless, or at least in no way equal to the cost of sulphuric acid. But the working of this battery was rendered not only economical but profitable, by adding to the iron and zinc cells prussiate of potash, which, when combined with the sulphate of iron, produced a splendid blue pigment of very great value—prussian blue; and that of a quality and colour far superior to any in the market. A second colour, closely vieing with ultramarine, was also produced by the same process. In another battery, of platinised lead and zinc, also invented by the discoverer of the Maynooth battery, chrome-yellow pigments were produced by adding bichromate of potash in the same manner as with the prussiate of potash. The tint of these pigments, which constitutes their value in the market, are varied by the proportion of the salts added. By combining the salts in a battery of iron and zinc—the prussiate of potash to the iron, and the chromate of potash to the zinc—a green colour was produced of a depth of tint dependent on the quantity of the two normal colours forming the compound. In like manner, by adding prussiate of potash to the lead battery, a white pigment is produced, of great body, and perfectly free from the fault of blackening by exposure to sulphuretted hydrogen. If chromate of potash alone were added to the iron battery, a deep brown colour is produced; and lastly, if lime were added with chromate of potash to the lead battery, a red pigment is formed of great brilliancy and body. During the working of the batteries, the hydrogen which escapes from the zinc cells is profitably employed for the manufacture of acetic ether and ammonia. The various pigments, when removed from the batteries, of course carry with them a large quantity of spent acid solution, which is also employed for the manufacture of nitrate of iron, white lead, and plaster of Paris. All the pigments which have been produced by electricity, the colour-trade have readily purchased; while the uniformity of the heat produced by the action of the batteries rendered the production of the most delicate shades a matter of certainty. The preparation of the colours for the market consists in nothing more than washing and drying.—*"Elements of Natural Philosophy," by Jabez Hogg.*

To Correspondents.

CAPT. S.—The subject shall receive attention in our next.

⁂ The first volume of THE ELECTRICIAN is now ready, price 10s. 6d.

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The Electrician.

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CONTENTS:

	PAGE		PAGE
Steps to Theory by the Practice of Electricity	13	Researches on Metallic Amalgams, &c.	20
The Transmission of Electrical Signals through Submarine Conductors	14	Notes and Memoranda	20
Some Considerations on the Principles of Electrical Conduction and Accumulation	16	Insulation of Aërial Wires	21
Bonelli's Electric Silk Loom	17	The Student	21
Experiments on Insulation	18	Electro-Magnetic Engines	21
Table of Experiments	19	Prices Current of Insulating Materials	22
Speed of Working Telegraph Lines	19	Telegraph Shares	22
		Telegraphic News	22
		Law Intelligence	22
		Correspondence	23
		Miscellanea	24

STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 3.]

201. WE must now, for the benefit of the student, briefly consider the purposes for which the condenser was originally designed, and is now frequently used in electrical researches. It sometimes happens that in experimenting we get a small electrical charge diffused over an insulated conducting surface so large, that we are unable by a direct application of the usual tests to ascertain even whether it be plus or minus, and much less to compare its intensity with that of any other charge. In this condition of things—as the artificial electrical equilibrium that has been set up does not annihilate the charge, but only conceals by apportioning it to the charging capacity of every part of the communicating surfaces, however extensive they be, and therefore with an intensity that is everywhere uniform, although insensible to our instruments—the condenser comes to our aid by enabling us to make such an addition to the charged surface as is capable of concentrating the charge mainly upon itself.

202. We have already had introduced to our notice, by the experiments which fig. 22 was intended to illustrate, means at our disposal for improving the charging capacity of a conductor insulated in the air, and by the instrumentality of the condenser those means are made comparatively perfect. We have also had an experiment (par. 149), in which we diminished the charging capacity of part of a conducting system, and thus caused charge to recede from that part to others; the condenser does for us the converse of this by affording a local augmentation of charging capacity. To make use of it we have nothing to do but to place its discs at the least possible distance apart compatible with the insulation of one of them while the other is in conducting communication with the ground, and then to bring the insulated disc into contact with any part of the charged system; nearly the whole of the charge then collects itself together in the insulated disc, still under the same feeble intensity, but in circumstances that cause it to be made intensely active whenever the distance between the discs is afterwards sufficiently increased.

203. If in the experiment to which we have just recurred (exp. 24), we had compressed and condensed the air, instead of rarifying it, around the ball in the receiver of the air pump, we should of course have reversed its result, and made it similar to that of the condenser; only it could never have been so marked, inasmuch as no improvement in charging capacity conferred by so limited an atmospheric induction as one of our small conductors admits of, is comparable to that conferred on the earth by its atmosphere for the plus electricity that escapes into it from the uninsulated disc of the condenser under the induction of the charged one.

204. While we have the condenser under consideration we may take the opportunity of introducing another form of instrument which answers certain purposes, for which Volta's is not calculated. A moment's reflection will be enough to convince us that the instrument we have been describing can under no circumstances possess itself of the whole of any electrical charge, because the conducting surface from which we might desire to abstract it all can never be wholly deprived by it of its charging capacity; and when the surfaces from which we have to withdraw it are insulating, it is inefficacious also for another reason. It sometimes happens when we are making experiments on excitation, and also in other electrical investigations, that it is desirable to have on some given conductor, consecutively, the whole of different charges from the surfaces of objects, whether they be of conducting or of insulating materials—which, when they are not large, we may easily do by taking proper advantage of electrical induction. The condenser we have used in many cases is simply a metallic tube six inches deep and two in diameter, closed by a hemisphere at its lower end, and fixed vertically on the upper extremity of an insulating rod and stand; when in use the instrument is nearly filled with water. The student will understand, without our adding to what has already been said on the subject of charging capacities, that whenever an excited rod of glass, of sealing-wax, of ebonite, or other nonconducting or insulated conducting matter is plunged into the fluid of this condenser every particle of the charge will be transferred to its external surface, where the aggregate may be conveniently estimated. In this way many successive charges, each by itself inappreciable, can be collected and made sensible.

205. The coated or Leyden jar, though only a modified electrical condenser, its outer and inner metallic coating serving the purposes of Volta's discs, differs from his condenser in two important particulars: first in form, and, secondly, in the substitution of glass for the air by which the conductors are isolated from one another. The jar may be charged by either of its coatings, the coating selected for the purpose acting inductively on the opposite one, as in the case of the condenser; or more correctly speaking, as in the experiments we have made with the ball encased in metallic hemispheres; for when the external coating is made to receive the communicated charge, part of it establishes artificial equilibrium with the adjacent atmosphere, which presents to it the appropriate conditions, so that the inner charge resulting from the induction is not equal to it; whereas if the internal coating receive the communicated charge, it dismisses necessarily from the outer coating an inductive charge as great as itself. These observations may be practically made with great ease if care be taken to remove the stem of the jar after sending in the charge by it; and with it of course all the electricity for which it may have charging capacity by reason of the air immediately around it.

206. It is commonly said that no plus electricity can be communicated to the inner coating of a Leyden jar unless an equal quantity leave its outer coating; that, however, is a mistake, as we can understand by theory and prove by fact. The inner coating will have some small amount of charging capacity conferred upon it by the circumstance of the charge being able to act inductively outwards until the action fall upon the insulated external coating, virtually, if not actually, liberating from it a portion of its natural electricity, which liberation is a consequence of the facility afforded by the surrounding atmosphere for placing the plus induced charge in the condition of artificial equilibrium; the whole reaction up to a certain amount of intensity being inferior to that of the machine supplying the charge. We may observe this to be true in fact by insulating a small Leyden jar in the manner shown in the figure, and suspending from a wire and ball projecting from its outer coating a pith ball electrometer; when we place the inner coating of the jar in conducting communication with the plus conductor of a revolving machine, the balls will instantly show their possession of a plus charge obtained by the induction, proving that the inner coating must first have become charged.

207. This leads us to mention, in confirmation of our explanation, a fact that has never before found a satisfactory solution. Electricians, following in the wake of Franklin, have supposed

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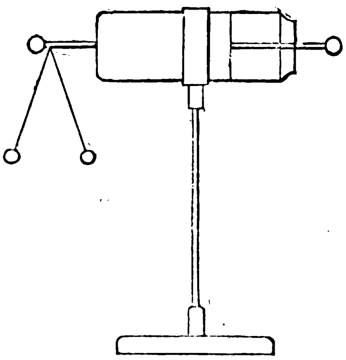
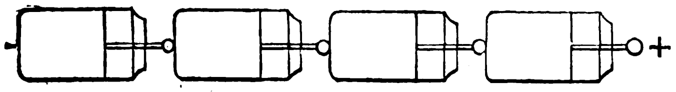
that for every unit of quantity of plus electricity thrown upon the inner coating of the jar, fig. 33, an equal unit, urged by it to

Fig. 3.



leave the outer coating, might be passed into another similar insulated jar, causing the outer coating of that second jar to dismiss an equal unit susceptible of being transferred into a third, and thus on without limit, provided only that the last external coating of the series of jars communicated with the ground or with the minus conductor of the machine. The following diagram

Fig. 34.



may serve to make apparent the effective parts of such an arrangement, where the signs + and — represent the opposite conductors of a machine. But in practice the result with a numerous series is not so perfect as it was thought it ought to be; to quote a writer upon the subject—"this experiment, although satisfactory when only two or three jars are employed, is greatly embarrassed by extension upon a long series—the last jars of the series do not become charged in the same degree as the first."

208. And why they do not we think every student will now be able to tell, with this slight suggestion to put him in remembrance: part of the plus charge induced in each of the external coatings finds artificial equilibrium in the surrounding inductive atmosphere; that part is therefore diverted from entering the jar with which it communicates; and not, entering, it cannot act by induction on its external coating. Hence there is a progressive decline in the quantity of electricity displaced from the external coatings, and consequently a lesser intensity at the last than at the first of the series.

209. The author from whom we have now quoted very philosophically attributes the decline of induction to a resistance opposed to it, but he adds, "When the resistance becomes at all equal to the charging power—the whole operation is thereby arrested." What the resistance is, how it should not be always equal, and how it ever gets to be so, he did not attempt to say; but he made this to be practically clear enough—the resistance did not increase in the ratio of the number of the jars, or he would not have found "two or three jars" inefficacious in increasing it. And to this we may add a result of our observation; we have practically found that when the large panes of our static battery, with coatings measuring 15 in. by 13 in. are put flat together, the induction will pass through any large number of them with the same effect as through the first one only; and our theory gives as the reason, that none of the charges except the first can find a contiguous atmosphere for diverting any part of its induction from the glass against which it lies, and in direction of the end of the series.

210. It is quite obvious that glass of other forms than the jar might be coated and used as electrical condensers. Panes of glass, for example, have been substituted, and found to answer precisely the same purpose, the theory of their charge, however, being that of the discs rather than of the jar. Tubes of glass, of any length, coated within and without, would be electrical condensers, their having no closed end, as the jar has, being quite unimportant, because it is not necessary to extend the coatings so far as to endanger their isolation from one another, and even though the inner coating were to pervade the whole length of the tube, projecting from both its extremities, if the outer coating were kept back a few inches from it, the insulation would be preserved. Instead of glass the tubes may be made of other materials capable of isolating the two coatings from one another, such as gutta percha, caoutchouc, resinous or bitumenous compounds, the selection being made in a commercial point of view for their economy of cost, and in an electrical point of view with reference to their inductive powers.

211. Here, then, we are at another electrical *étoile*, and one of the subjects branching out from it is the theory of the electrical telegraph; we propose to follow its leadings in our next, and we can promise our readers who have qualified themselves for entering with us into that interesting and important matter a clearer view of it than they have been accustomed to, and one through which improved practice is probably to be attained.

(To be continued.)

ON THE TRANSMISSION OF ELECTRICAL SIGNALS THROUGH SUBMARINE CONDUCTORS.

It has occasionally been suggested by those whose statements and opinions are depreciatory to the present position and prospects of submarine telegraphy, that the progress of science may one day place within our reach the means of signalling with a vastly increased speed through a submarine conductor constructed on the most economical principles. It is not within our present purpose to comment upon the obstructive application of this very plausible opinion, but to endeavour to show that science in the abstract has already progressed to a point which may allow of many new and important applications. The facts which are even now registered in science, and which may be extended and practically applied in submarine telegraphy, will probably suffice to attain the degree of perfection of which the latter may be susceptible. We cannot assume that we have reached the *ultima thule* of invention; but we cannot, on the other hand, suppose that we should perforce have to remain *in statu quo* until scientific discovery shall have enlarged the boundaries which already afford so great a field for endeavour. Those who labour to discover and to investigate facts, without any reference to their applications, or to their apparent value, except as fragments of the mighty entity of truth, have already given sufficient materials, perhaps for many years to come, to those who build up our progress by extending these facts in their bearings upon the practical problems of life.

We consider the two classes as distinct; and to a certain extent they are so. The discoverer—the man of abstract science, never becomes an inventor, still less a *patentee*, without in some degree losing caste. Standing on the highest ground, he then descends one step or more. But again it is difficult for him to arrive at an appreciation of all the requirements of practice. The inventor, the practical worker in science, may often be led into the investigation of abstract principles, and to the discovery of new truths; but the natural tendency of his mind is ever to apply what he may obtain, and he values this accordingly.

The effects of static induction constitute the principal evil to be combated in submarine telegraphy. It has been endeavoured, with some success, to remove these effects; but not to obviate them by removing their cause. Nevertheless, it must be admitted that the working conditions of long submarine circuits have been greatly improved. We have a dielectric of less inductive capacity which we may adopt if we think fit, we are prepared to

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employ a conductor of greater sectional area than heretofore, and we propose to work by means of reverse currents, or to adopt other effectual means of neutralizing, as quickly as may be, the residual charge. All that can be done in this particular direction has probably been accomplished. We may now give our attention to other considerations, perhaps to an entirely new system, if such be possible, of working submarine wires. In the meantime, let us remain satisfied, *for the present*, with our actual position. No new system will start, MINERVA-like, into being, without acquiring the element of time to secure its safe adoption. It is not alone that ocean telegraphy cannot afford to wait, but several of the possible systems of working might be applied and tested upon cables of the present construction.

It has sometimes been held as an axiom in voltaic science that, whatever may be the generating power of an electromotor, no more electricity can be evolved from it at any moment of time than can traverse the voltaic circuit, in this period, at the tension given; or, in other words—that the quantity of electricity liberated from the source is inversely proportionate to the resistance of the circuit. It might be observed that telegraphists appear to have acted upon this axiom in allowing always the possible production of a surplus quantity by the battery. We have ample experimental evidence that the dictum in question is by no means absolutely correct, and in submarine telegraphy it is not approximately so. Under certain conditions, which we shall sufficiently advert to, it is possible to increase the resistance of the circuit, and at the same time to increase the quantity of electricity expended in the production of signals, and this without augmenting the battery tension. To obtain these conditions it is only necessary to diminish to a certain extent the specific conductivity of a submarine conductor, whilst preserving its absolute conductivity, or again, to increase the surface for induction by giving to the conductor the form of a tube, whilst its specific degree of conductivity remains unaffected. A galvanometer placed in circuit at the distant extremity of the wire will indicate, in this as in other instances, the passage of the electricity which traverses the circuit; but a galvanometer at the battery end will show in addition, each time a signal is transmitted, the passage of the quantity necessary to effect the static charge of the conductor. We need scarcely observe that the latter quantity *may* be greater than that which produces the required dynamic effect. What would be the result of reducing the quantity of electricity generated by the electromotor to that which can be freely conducted in the circuit, and which will be indicated upon the distant galvanometer? Can any further supply be otherwise than prejudicial to the working of the of line? These are among the questions which we propose to ourselves and to our readers to answer both in theory and in practice.

To the question—whether it be possible to transmit a current of electricity through a submarine conductor without the production of a static effect, an answer was once given which reminds us of those of the witches in Macbeth—

> "Which kept the word of promise to the ear
> But broke it to the sense."

The means suggested showed this desideratum to be possible, but certainly did not tend to establish its practicability. If we take an insulated wire of any length, and enclose it within a tube of metal which also is covered with insulating material, we may place the compound conductor in earth or water, and employ the inner conductor for the transmission of signals while the tube remains insulated. If, now, we charge the tube from the positive pole of the battery, the negative terminal being led to earth, and at the same time transmit a current from the positive pole through the inner wire, the electricity in this conductor will pass freely "without the production of a static effect," since it can exert its inductive action only upon the inner surface of the tube which is connected with the positive pole of the source, and which is therefore maintained in a condition of positive tension. Unfortunately, as observed by Mr. LATIMER CLARK, the outer tube is even more difficult to charge than is a wire under ordinary circumstances, on account of its greater inductive surface; and if it has to be charged and discharged before and after every signal transmitted through the wire, there is obviously nothing to be gained by the arrangement. If, on the other hand, it be maintained in a condition of positive tension, the inner wire becomes negative by induction when battery contact is broken, and requires therefore to be charged positively before a fresh signal can be transmitted. But what we desire to observe, in regard to these and other conditions under which the inductive effect does not occur to an appreciable extent, is—that the supply of electricity from the battery is by these conditions regulated to the amount which can be freely conducted by the wire. When such conditions are absent, and electrical induction can take place, it devolves upon ourselves to regulate the supply of electrical agency in order to reduce the static charge to a minimum, and thus to avoid the retardation due to the effect of discharge. It remains to be proved whether *any static effect* can occur when the supply of electricity at any given tension is duly proportioned to the resistance offered by the conductor.

It is possible, we will even say probable, that static induction, which has hitherto been of such detriment in long submarine lines, may be converted into a useful agency. We are not aware that any plan has ever been proposed or suggested for working such lines by means of induced electricity; but we believe that experiments are about to be made in this direction. We cannot at the present moment enter into the consideration of the possible advantages of this system, nor of the peculiar arrangements which might be adopted to secure them; but a rough outline of this plan may be of interest to many of our readers. Let us take the form of cable which has been above-described, consisting of a central insulated wire and tubular conductor surrounding this wire, and also covered with insulating material. If we charge with plus electricity the inner conductor insulated from earth at the further end, a current of electricity in the same direction as that of the charge will take place in the outer conductor connected to earth through the signalling instrument at the distant station. This current is, of course, temporary, being a true "discharge" of plus electricity. When battery contact is broken, an induced current in the opposite direction will traverse the outer conductor, or the negative tension may be neutralized by the battery previously to breaking contact with the inner wire. The signals would, probably, be made to depend upon the alterations in the direction of the induced discharges. We may leave those of our readers who have studied the various problems of static induction to arrive at their own conclusions respecting the value of the system we have glanced at, or any of the more obvious modification of the same.

While upon the present subject matter, we may refer to the use of the electrometer as an instrument for receiving electrical signals—an application which appears to be somewhat vaguely suggested in one of the supplementary reports attached to the Report of the Government Commission. It is not necessary that we should point out that an indication of an electrical charge might be obtained through the electrometer, in a shorter space of time than would suffice for the passage of a quantity sufficient to effect a galvanometer, or electro-magnet, when the wire is led to earth. The deflected needle might be made *partly* to discharge the wire, and a second signal would then be produced by contact with the same pole of the battery at the transmitting station, without the necessity for fully charging the cable. We are fully conscious of the many objections which may be brought against the use of so delicate an instrument, as well as against other methods for the transmission of signals which we have adverted to. But, with the present means at our command, we have ample opportunity, as well as some occasion, to seek for improvement in every possible direction. Our object is to promote experiment and research, and we are content if we have furnished some

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materials to those who look forward to progress, and are prepared to earn it by endeavour.

From our present point of view, perhaps the most practical recommendation we could urge upon those who would increase the rate of working through long submarine wires, is the regulation of the battery power in regard to quantity, and the adoption—if not of Professor HUGHES' printing instrument, at least of the HUGHES magnet in some modification of the MORSE instrument. The extraordinary delicacy of this form of magnet, and the advantages it offers in other respects, have already received some appreciation, and are likely to be held in greater value when the question of the speed of transmission, dependent in great measure upon imperfections in the signalling apparatus, will determine the commercial practicability of ocean lines of telegraph.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 5.]

I HAVE thus far given the investigation of three classes of inductive circuits, viz.:

1st. That composed of successive resistances.
2nd. That composed of branch resistances only.
3rd. That composed of branch resistances having also a resistance common to each branch.

I have given, at the risk of appearing prolix, not only the formulæ for calculating the alterations in quantity and density produced in each case by the alteration of one of the resistances, but the working out in figures of several examples, as I believe this the best way of making such questions clear.

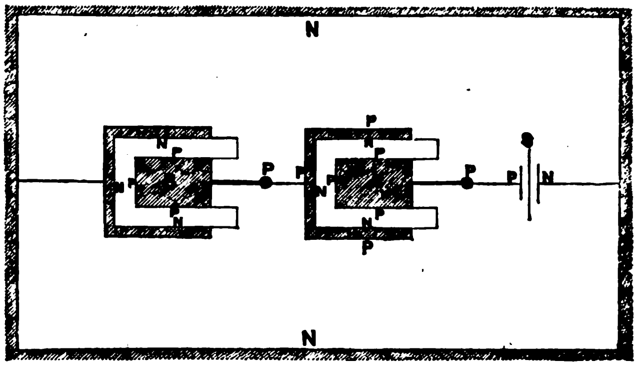
Whenever we can define the inductive circuit, and the resistances are either prismatic, or are such that they may, within certain limits, be treated as such, these formulæ may be applied without any further detail. If the resistances be cylindrical, then if their thickness bears any great ratio to their radius, or if they are increased in the direction of their thickness beyond a certain extent, from what I have already pointed out, they can no longer be treated with any degree of accuracy as prismatic resistances. The alteration in each particular resistance must in such case be calculated by the formula $R = \text{Log.}\frac{D}{d}$, and the formula for obtaining the total quantity generated at either pole under the new conditions applied. This being obtained, it is easy, from the other formulæ, to obtain the quantity in the altered branch, which, divided by the surface, will give the density. If the resistance has been altered by an alteration of D only, then the inner surface of the resistance will be evidently unaltered, and the density on the inner surface will be found by dividing the new quantity by the old surface. If the density is then required on the outer surface, the new quantity must be divided by the new surface. And in the same way, if both d and D are altered, the new quantity must be for each case divided by the new surfaces. It is evident that as in a cylindrical resistance, the resistance is proportional to $\text{Log.}\frac{D}{d}$; if D and d be both increased in the same ratio, so that $\frac{D}{d} = \frac{D'}{d'}$, the resistance will be unaltered, and consequently the quantity will be unaltered; as, however, the surfaces are altered, the density will be altered on both the interior and exterior surfaces, and must be found by dividing the old quantity by the new surfaces. If the resistances are cylindrical, and of considerable length, so that any effect at their terminations may be neglected, then, if increased in length, a proportionate increase of surface occurs, and we obtain the same effect as increasing the surface of a strictly prismatic resistance. Thus in the case of submarine cables of different lengths, but of the same pattern, the formulæ can be applied with the greatest facility.*

In many cases of electrical accumulation the experimenter may, at first, when comparing the laws I have ventured to point out with regard to inductive circuits, with the results of direct experiment, be likely to find apparent anomalies and contradictions; these, I venture to assert, will be found to result from an imperfect interpretation of the actual conditions of the case.

Thus, according to one of the first principles, viz.:—that the quantity on each successive surface of an inductive circuit composed of successive resistances only, is constantly the same throughout the whole circuit—it would at first sight appear that if we have a succession of Leyden jars, the interior of one being connected to the exterior of the next, one extreme jar being connected to the prime conductor, and the other through earth to the rubber, we should have an inductive circuit composed solely of successive resistances, and equality in the charge of each jar might, according to the above law, be expected, whereas we know that such a result would not be obtained.

A little consideration of figure 55 will show, however, that

Fig. 55.



such an arrangement, of say two jars, is really a *branch inductive circuit having a common resistance.* Thus we can trace the circuit from P side of the source to the interior of the jar A, thence across the glass to the exterior coating; from here the circuit branches, one branch continuing across the air to the surrounding objects, which are in communication with the N side of the source; the other branch passing on from the interior of B (which is in connection with the exterior coating of A), through the glass of B to the outer coating, which is in connection (through the surrounding objects), with the N side of the source. Now here the glass of A is the common resistance, the air between the exterior coating of A and the surrounding objects is the resistance of one branch, and the glass of B is the other branch. Calling these respectively r, r', and r'', and the quantities on their respective surfaces Q, q, and p, then Q must equal $q+p$. Therefore p equals $Q-q$; but Q and p are the charges of the jars A and B respectively; the quantity q being a charge of positive electricity on the exterior of the outer coating of A†, and having its opposite and equal opposing charge on the surrounding objects. The jar A contains a charge therefore on its glass surfaces exceeding that of B by a quantity exactly equal to this charge p on the exterior of A. If all connections be now broken, then by touching the exterior of A to the surrounding objects the quantity q will be annulled without altering the charge of A, which *still exceeds the charge of* B by a quantity exactly equal to this charge q, which we have just annulled. It will be also evident that as the proportion of q to p will depend on the proportion which r'' (the re-

* I have lately, through the courtesy of Mr. Chatterton, the General Manager of the Gutta Percha Company, been enabled to test these formulæ on six lengths of submerged wire, each 7½ miles long, grouped together in a variety of ways, to the two poles of the battery. The results were quite in accordance with the calculations, but I shall not attempt to detail them now, reserving them for a part of this work where they may serve also as examples of another branch of the subject.

† This charge q, on the outer surface of A, is what would be termed by some electricians "free electricity."

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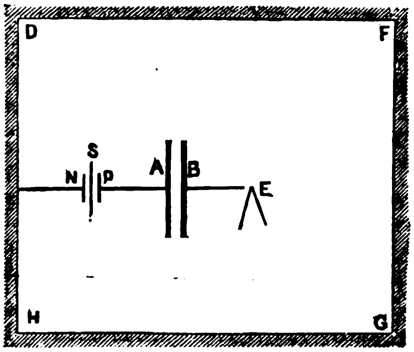
sistance of the glass of the jar B) bears to r' (the resistance between the exterior of A and the surrounding objects), the more we decrease r' by approaching the surrounding objects to the jar A, the greater will be the difference between Q and p, or the charges of the jars A and B.

It would be easy to trace similar cases with more jars in a variety of forms, but would take up more space than can be devoted to the subject.

It has been shown that the quantity accumulated on any one surface in a circuit with a given source, will be inversely proportional to the sum of all the resistances of the circuit, and that consequently when we halve the total resistance of the circuit, the quantity on any one of the remaining surfaces will be doubled. In attempting to test this law in some forms,* by direct experiment, it is necessary to trace carefully the whole of the inductive resistances of the circuit, for otherwise we may be led to believe that we are halving or doubling the resistance of the whole circuit, whereas we are really only altering one resistance forming only a part of the whole resistance of the circuit, and if this part be small compared to the whole resistance of the circuit, its alteration (even if it be doubled or halved), will produce but little alteration in the *total* resistance of the circuit, and thus the results would, of course, not accord with the expected result.

Thus for instance, suppose A and B (fig. 56), to be two flat

Fig. 56.



plates opposed to one another, B being connected to an electroscope, and A to the P side of a source S, the N side of which is connected to the surrounding objects, D, F, G, H. It might be supposed that the doubling or halving the distance between the plates A and B (since we are altering the only apparent resistance), will produce a proportionate effect on the electroscope. No such result could, however, be obtained, nor should it be expected, for if we trace the inductive circuit, we shall see that the resistance between A and B forms only a *small part* of the *total resistance of the inductive circuit.* For the circuit in which the electroscope is situated can be thus traced, from P to the plate A, and thence across the resistance R to the plate B, thence partly to surrounding objects, and partly to the electroscope, and from thence across the air to the surrounding objects which are in conductive connection with the N side of the source. The resistance between the electroscope and the surrounding objects will evidently be very great, as compared to the resistance between the two flat plates, by virtue of the small surface of the electroscope, and the distance of the surrounding objects. By halving or doubling the resistance between the plates we should therefore only halve or double the resistance of a *small portion of the total resistance.*

To illustrate this by figures, suppose the resistance between the plates be 1, and that from the electroscope to surrounding objects 100, then the resistance of the whole circuit will be 101; and if we double the resistance between the plates the resistance of the whole circuit will be altered to 102, which will consequently only alter the quantity on the electroscope from 100 to 99, and consequently scarcely any effect on the electroscope will be visible.

If to each insulated pole of a source similar electroscopes be attached, and the surrounding objects be equidistant from each electroscope, then we shall have an inductive circuit formed of two equal resistances, viz.: from each electroscope to the surrounding objects, and a certain equal quantity will be generated at each pole, and become resident on each electroscope, which will indicate this equality by equal divergence. If now one pole be connected to the surrounding objects, we have the resistance of the inductive circuit, one electroscope will cease to diverge, being now only a part of the surrounding objects. The other electroscope will increase its divergence, and if it be of such construction that the quantity can be measured, it will indicate double the quantity previously existing on it.

An endless variety of inductive circuits may be imagined, and treated with more or less facility in the manner shown; but as many examples have been given as space will permit, and enough, I believe, to illustrate this mode of dealing with electrical accumulation from a given constant source of generation.

(To be continued.)

* In the form of experiment on this subject given on page 197, fig. 36, no such misconception as to the resistances of the circuit would be likely to occur.

BONELLI'S ELECTRIC SILK LOOM.

A CONSIDERABLE portion of the electrical apparatus sent to the International Exhibition from abroad, had not yet been arranged at the period of our visit to the building, in the early part of the week. We looked in vain for the electrical silk loom of the Chevalier Bonelli, which is to be exhibited, and which will constitute one of the most interesting of the various applications of electricity to be exemplified. The following description of the machine, abstracted from a paper by Professor Faraday, will be acceptable to those of our readers who may have some acquaintance with the construction of the Jacquard loom:—

"The astonishing condition of perfection to which M. Jacquard had brought the silk-loom, so that artists of the highest rank could not, without minute inspection, distinguish its results from the most perfect engraving, and the manner in which he taught the weaver to construct a series of cards, and then to use them automatically, so as to produce, as often as he pleased, the design which they represented, are well known. Any effect of pattern, either simple or complicated, which is produced in the woven fabric, depends upon the manner in which the threads of the warp are separated before the weft is thrown, and the successive rearrangements of the warp threads which are brought about each time the shuttle is passed. A single thread of the weft, therefore, represents an element of the design; and in the Jacquard loom, each of these required a card pierced in a certain order, which being brought against the ends of a set of horizontal rods, allowed some to remain undisturbed, whilst others were pushed on one side. By the action of the pedal the warp-threads associated with the undisturbed rods were raised, and those belonging to the displaced rods were left unmoved; and to do this rightly, a separate pierced card was required for every thread that crossed the warp within the extent of the pattern. Frequently some thousands of cards are needed, and for the production of a woven portrait of M. Jacquard, in black and white silk, as many as 24,000 were employed.

"After a design has been decided upon, it has to be converted into these cards, one for each thread of the weft included in the design; the preparation and piercing of them requires much care and time, after which they have to be linked together as an endless chain in their proper order. It is to replace this part of the weaving arrangements that M. Bonelli has applied his attention, and the peculiar power of electricity. Instead of the many pierced cards, he has but one card, or rather its equivalent, a convertible plate of brass; which being pierced with the full number of holes required (which in the loom in action was 400), can have these holes either stopped or left open, so as to represent by its successive changes of condition, the successive cards of the Jacquard series. To obtain this effect, tin foil is attached strongly to paper, so as to form a compound sheet. The design is then drawn upon the metallic surface with black bituminous varnish, and the sheet is made into an endless band, which being placed upon a roller, and kept in its position by stops, moves as the roller moves, being carried forward by its motion. A set of teeth rests upon the top of

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this roller, touching the pattern in a line; they are made of thin brass plate, so that 400 of them do not occupy more than 16 or 17 inches, *i. e.* the width of the design on the roller; yet so separate that each is insulated from its neighbour by little interposed teeth of ivory; and so large, and therefore weighty, as to fall and rest upon the pattern, making good electrical contact where the tin foil is exposed, but being insulated where the bituminous pattern intervenes.

"Behind these teeth are 400 small electro magnets fixed in a framework, parallel to each other, and insulated. The fine covered wires which constitute their helices are connected at one set of ends with the teeth just described, each with a tooth; whilst the other ends are brought together and made fast to one metallic plate and wire. Tracing this wire onwards, it comes to an interruptor or contact maker, from whence the metallic communication proceeds to a screw appointed to communicate with one end of a five-celled Bunsen battery, the other end of which communicates with a screw near the former. This screw has a wire proceeding from it to two insulated teeth, like the teeth bearing upon the pattern, but heavier; and these rest upon the uncovered edges of the tin foil at the sides of the pattern, so as to keep up a constant electric communication with it. By simple but perfect and secure mechanical arrangements, the following movements and results take place in this part of the apparatus. As the pedal descends under the weaver's foot at a certain time, the 400 teeth descend upon the pattern; then the circuit is completed at the interruptor in the single wire; the electric current passing through that wire is divided into as many portions as there are teeth touching the metal in the line of pattern under realization; it makes all the electro-magnets surrounded by these wires active, leaving the others non-magnetic; and then, as the foot is raised and the movements return in their course, the interruptor is first separated, which, causing all current to cease, the magnets lose their power, the teeth are raised from the pattern; and then the cylinder carrying it moves forward just so much as to give the new line of pattern for the teeth to search out electrically (the next time they descend), which corresponds to the next cast of the weft thread. Because the pattern never moves, whilst it is in contact with the teeth, it is not cut or worn by them; because the current is made by the interruptor after the teeth are in contact, and before they are separated, no fusion or burning of the metal occurs at the teeth; and because there is a tongue-like wiper or brush, which at the right time passes under the teeth, sustains them, and from off which they rub on to the pattern, there is never any want of cleanliness or of contact there.

"Associated with these 400 magnets, and in the same line with them, are 400 cylinders of soft iron, called pistons; they are carried in a frame which moves to and fro horizontally between the magnets and the horizontal rods belonging to the suspensions of the warp threads; and they move towards the magnets at a time so adjusted as to coincide with the passage of the electricity round its circuit: they find therefore some of the magnets excited, because their teeth touch the metal of the pattern; and, as the box of pistons begins to return before the current is interrupted, such of the pistons as have touched excited magnets are retained or held back, whilst the others have returned in their course: the pistons, therefore, are divided into two intermixed groups, of which the one group is perhaps half an inch behind the other. Now comes in the action of the perforated brass plate, which is to be converted for the time into the equivalent of the particular Jacquard card required. It is a vertical plate, associated with the extremities of the pistons farthest from the electro-magnets; it can move up and down to a small extent; it is pierced by 400 circular holes. The 400 pistons have each a head or button, which can pass freely through its correspondent hole when the plate is up, but is stopped at the hole when the plate is down, and then effectually closes it. Now the time is so adjusted, that when the box of pistons has moved so far forward as to cause separation of the two groups, the plate descends, and by locking such of the heads as belong to the unretained group, fills the correspondent holes, whilst the heads of the retained group, being already behind their holes, have left them open; and so the Jacquard plate is formed, and, moving, a little further it acts on the horizontal rods before mentioned, and having by that arranged the suspenders of the warp threads, it then goes back, or towards the electro-magnets, to take up under the influence of the currents of electricity through the selecting teeth, the new arrangement of apertures required for the next cast of the weft thread.

"The use of electricity, for the purpose of reading off the design and conveying it into the loom, involved many peculiarities, conditions, and difficulties, which have been either turned to advantage or overcome."

EXPERIMENTS ON INSULATION.

BY MR. OWEN ROWLAND.

[*Appendix No. 6 to Report of Government Committee.*]

Impurities, Air Cells, Fissures, and Eccentricity of Conductors.	Cores of Submerged Cables.
Gutta Percha Sheets.	England and Holland.
Gutta Percha covered Wires.	The Atlantic.
India Rubber Sheets.	Subterranean Wires.
India Rubber covered Wires.	Elongation or Stretching of Cores.
	Effect of Temperature.

The method adopted for testing sheets, consisted in placing horizontally upon a metallic disc, six inches in diameter, a plate of glazed porcelain. From the disc a copper wire was passed through a very delicate galvanometer to earth. The sheet was then laid over the disc, extending a few inches beyond its circumference. A copper rod, in contact with a battery of 512 elements, having one end slightly bent, and the other inserted in an insulating handle of ebonite,* was carefully passed over the surface of the sheet, corresponding in size with the metallic disc beneath, so that when the testing wire passed over a fault the passage of the current to earth would be instantly indicated on the instrument.

In the *gutta percha sheets*, some of about the thickness of common tissue paper, others of about one thirty-secondth of an inch in thickness, the faults discovered were almost invariably owing to impurities, in the shape of dark brownish spots, which occurred sometimes singly, at other times in groups. Examined with the aid of a microscope, these spots had the appearance of a decaying fibre. In a few instances the defective insulation of a sheet was owing to minute fissures, detected by thoroughly wetting the sheet with water, and upon a microscopic examination the edges of the fissures seemed as if cut with a sharp instrument, and not the effect of stretching. With the exception of the impurities or fissures, the insulation tests were generally uniform.

In sheets of *masticated india rubber*, of about one thirty-secondth of an inch in thickness, on two occasions the insulation was deteriorated by impurities, but not by fissures.

Gutta Percha covered Wires.—The method adopted for testing short pieces of covered wires consisted of a small porcelain vessel filled with water, and an earth-connecting wire. The short piece of covered wire was bent horse-shoe shape, and inserted in the water, leaving out about four inches of both ends, one end being insulated, the other brought into contact with a Peltier electrometer. The loss of insulation was then ascertained in the usual manner, 512 elements being employed.

In the very numerous pieces tested, inferior or faulty insulation was found to arise from either of the following causes: impurities or extraneous matter, air cells, fissures, and the eccentric position of conductor. The tests otherwise exhibited an uniform insulating quality.

India Rubber covered Wires.—No defective insulation was, however, found arising from impurities of air cells, cavities, or eccentricity of conductor, in india rubber covered wires.

Masticated rubber cores become much firmer by prolonged submersion in water, and in colour and structure much resemble the material in its virgin state.

Cores of Submerged Wires.—About a dozen kinks were examined which had been formed in submerging the cable laid between England and Holland, and which had been submerged for about five years. The core was stripped of its iron and hemp sheathing, and it was found that the gutta percha had been so compressed by the kinking as to reduce its thickness from four thirty-secondths of an inch to less than two thirty-secondths of an inch. The insulation equalled that of other pieces cut from the same cable which had not been affected by kinks, or otherwise, and was far superior to that of new plain gutta percha.

A piece of the Atlantic core submerged near the coast of Newfoundland for upwards of two years, was also tested against other lengths of new gutta percha cores, and found far superior in its insulating capacities.

Gutta percha when long submerged in sea water seems to assume a clearer, tougher, and denser appearance.

Subterranean Wires.—It was always found that the insulation of the gutta percha was very deficient, *even in the parts best preserved*, when brought to the International and Electric Telegraph Company's works from different parts of the town and country, many portions having absolutely decayed and become worthless for the purposes of insulation.

Elongation or Stretching of Cores.—In the manipulation of cores such as in drawing cables along subterranean pipes, or in paying out of vessels, the greatest precautions should be taken to avoid vio-

* A material possessing superior insulating qualities.

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lent stretching or elongation. The composition or structure of gutta percha is materially deteriorated thereby, and the insulation often permanently impaired. Sometimes it has been found that a very slight elongation caused a very great diminution of insulation, owing probably to the distension of air cells or cavities, or defective material. India rubber, from its tenacity, is not so liable to be similarly affected, but in the course of experiment it has been found that violent stretching has an injurious effect upon its insulating properties, both in the shape of sheets and cores.

Effect of Temperature.—In Table No. V. of experiments on the insulation for dynamic electricity, experiments 6 and 9, the loss and return of insulation under the influence of temperatures is shown, and from numerous additional tests made during the duration of the experiments, with the view of determining the highest degree of temperature to which gutta percha (plain), and india rubber covered wires might be subjected with safety, it is evident that gutta percha should not exceed 95 degrees, and india rubber 140 degrees.

The general result of the above tests clearly demonstrates that superior insulation depends upon the purity and the homogeneousness of gutta percha and india rubber coatings respectively, and that to secure an uniform and permanent insulation, air cells, fissures, eccentricity of conductor, and violent stretching or elongation should be avoided in the manufacture and manipulation of telegraphic cores.

TABLE OF EXPERIMENTS MADE ON THE INDUCTION OF GUTTA PERCHA EXPERIMENTAL WIRES WITH VARIOUS GALVANOMETERS.

Description of Wire.	Diameter of Copper.	Thickness of Coating.	Number of Cells.	No. 1 Galvanometer Discharge.	Calculated Discharge.	No. 2 Galvanometer Discharge.	Calculated Discharge.	Number of Cells.	No. 3 Galvanometer Discharge.	Calculated Discharge.	No. 4 Galvanometer Discharge.	Calculated Discharge.
	inch	inch		°		°			°		°	
Gutta Percha -	·0625	·0987	512	7·2	8·	11·2	12·	128	15·9	18·	25·5	27·
1 mile	·0625	·1875	„	5·	5·34	7·8	8·	„	12·2	12·	18·7	18·
	·0625	·3750	„	3·8	3·56	5·8	5·34	„	9·	8·4	14·	12·
	·0625	·0937	„	7·2	8·	11·2	12·	„	15·9	18·	25·5	27·
	·125	·0937	„	12·	12·	18·	18·	„	25·	27·	40·	40·5
	·25	·0987	„	15·7	18·	24·	27·	„	81·	40·	53·	60·2
	·0625	·1875	„	5·	5·34	7·8	8·	„	11·9	12·	18·7	18·
	·125	·1875	„	7·9	8·	11·8	12·	„	16·	18·	27·	27·
	·25	·1875	„	12·	12·	18·	18·	„	25·	27·	41·	40·
	·0625	·375	„	3·8	3·56	5·8	5·34	„	9·	8·	14·	12·
	·125	·375	„	5·	5·34	8 2	8·	„	12·	12·	19·5	18·
	·25	·375	„	7·9	8·	12·	12·	„	16·6	18·	27·	27·

No. 1.—Gaugain Standard Galvanometer.
No. 2.—Ditto, new do. do.
No. 3.—Ditto, Suspension do. do.
No. 4.—Mr. Henley's Large Suspension.

Wires ·065, ·875
Do. ·26, ·1875
Wire ·0987
} are evidently both over coated, or less than a mile in length.

It will be observed that the Galvanometers 3 and 4, with 128 cells, do not follow the law of the discharge so closely as No. 1 and 2 with 512 cells. The great length and weight of the needles and the great difficulty of bringing them into complete state of rest, will account for an apparent irregularity in the deflections especially when the higher readings are taken.

MR. C. VARLEY ON THE SPEED OF WORKING TELEGRAPH LINES.

(*Minutes of Evidence taken before the Submarine Telegraph Committee.*)

The limit of speed in a telegraph line depends upon the rapidity with which the wave flows through that line, and also upon the apparatus itself. In an over-ground circuit, such as that from London to Edinburgh, in which there is but a small amount of gutta percha covered wire, the wave travels so rapidly that it may be almost entrely neglected; but apparatus such as will work without giving too much trouble must be rather heavy, to possess sufficient force to close and open the local circuit with precision. Such apparatus have not a very high rate of speed, they will not exceed 35 words per minute through a line of 200 miles of No. 8 iron wire unless exorbitant battery power be used. In practice we are obliged to allow a very large margin, because you never can find telegraphists who are, in the first instance, sufficiently expert to keep the apparatus adjusted to the highest pitch while receiving and writing a communication; we are, therefore, obliged to allow a very large margin, in order that the instrument shall work throughout the day without any material interruption. In practice we seldom work on the English lines at a higher rate than 22 words per minute. An entire hour's work will seldom show a higher speed than 12 or 15 words per minute. The average length of words is 4½ to 5 letters, but the public when telegraphing, often suppress the "a's," the "of's," the "the's," the "in's," &c., and thus telegraphic words average of a greater length, and very often exceed 5 letters, especially when such words as the following occur in the message, "Dampfschifffahrtgesellschaft," which, according to telegraphic law, is a single word all over Europe. In working through a line in which you are limited by the rapidity of the wave; for instance, in an underground wire of considerable length, you ought to take not more than one-third of the attainable speed as the available speed for communication. There are very many sources of interruption to telegraph lines; first of all, the batteries at times fail; the apparatus get out of order from wear or breakage; the wires connected with the apparatus break; the apparatus of the receiving station require re-adjustment; and where Morse instruments are used the burning of the contact points in the relay

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makes them rough and liable to adhere, when the contact parts (made of gold or platinum) must have their surfaces renewed by being filed or cut with a knife. There are many other small sources of irregularity, which, when put together, make a rather large total. I am not now speaking of the interruptions which arise from the currents leaking from one line to another, or from defective insulation; I am speaking simply of interruptions that are peculiar to the apparatus themselves. Another source of interruption, which is a serious one, is that the clerks at the instruments sometimes get out of temper. I have noticed that telegraph working generally causes great nervous irritation, and the clerks are very prone to quarrel. This is particularly the case with those circuits which are difficult to work, from the above numerated causes. The quarrelling is a thing we cannot entirely check, and it is a source of reduction in the available speed of telegraphic lines. If a clerk be thoughtless, and do not "key" very accurately, and so cause one or two words in a message to come indistinctly, the clerk at the distant end, after this has been repeated two or three times, will frequently become so excited as to refuse to work; quarrelling commences, which ends frequently in serious delay to the working of the line. We do all we can to check this, but cannot entirely prevent it. These are some of the elements which enter into the calculation as to the availability of a line for commercial purposes, and taking them, together with the other sources of interruption, you ought not to allow more than one-third or one-fourth of the attainable speed through a cable for its practical capacity, and to maintain this throughout the 24 hours would be a hard task for the most expert hands.

RECENT RESEARCHES ON METALLIC AMALGAMS, AND ON THE ORIGIN OF THEIR CHEMICAL PROPERTIES.

BY M. J. REGNAULD.

In a preceding work I have shown that the chemical properties of amalgamated zinc and cadmium, are connected with the thermic phenomena which take place at the moment when these two bodies are united to mercury. My recent investigations tend to generalize these relations. These investigations extend over a considerable number of metals, and prove that, by the fact of amalgamation, some, such as zinc, rise in the scale of positive affinities, while on the contrary, others, such as cadmium, are lowered.

Among the metals submitted to these comparative experiments, the following, when allied to mercury, become electro-positives: Iron, nickel, cobalt, zinc, tin, antimony, copper, lead, bismuth.

Among these bodies only zinc, tin, and lead combine with mercury by simple contact, and without auxiliary, physical, or chemical action. I have ascertained that during the amalgamation of tin and lead, and likewise zinc, the temperature is not lowered. Thus then, in all three cases where the temperature can be observed during the reaction, it is found that the positive affinity of the compound augments when the heat of its constitution increases.

Hence it may be concluded that other amalgamated metals, having identical properties, owe them to the same cause. Let me add that a comparison of their latent heat of fusion, and of the chemical rank they hold, is very favourable to this point of view. It is easy to be convinced of this by examining the table in which the latent heat of fusion of the metals experimented upon, are shown. Some are exact, and are the result of calorimetric determinations; others have only approximate vapours, deduced from the relation established by M. Person, between latent heat, the co-efficient of elasticity, and the density of the metals.

	Latent Heat of Fusion.	
Iron	64·171	Calculation.
Nickel	55·397	„
Cobalt	51·633	„
Zinc	28·130	Experiment.
Tin	14·252	„
Antimony	12·455	Calculation.
Copper	33·881	
Lead	5·369	Experiment.
Bismuth	12·640	„

The affinity of the three first metals of the table with mercury differs very slightly from that of the zinc; and as their latent heat is decidedly superior to that of zinc, the increase of positive affinity in the amalgams is due to this circumstance.

The electro-chemical properties of the amalgamated metals placed below zinc are also explicable on the same principles. In fact, if on the one hand their latent heat is generally inferior to that of zinc, on the other hand they unite with mercury in virtue of so feeble an affinity that the formation of the alloy lowers the temperature, as is the case with tin, and even with lead.

As to the metals analogous to cadmium which disengage heat during amalgamation, and which, according to theory, ought to be lower in the scale of affinities, their place in the group of metals is, through their electro-positive property, far removed from mercury. Their combination with mercury is the consequence of an energetic affinity, and as their fusing heat seems otherwise to be feeble, the heat produced during the reaction is of remarkable intensity.

Potassium and cadmium, the amalgamation of which is attended with the production of heat to the extent of incandescence, have suggested to me a new bearing of these ideas. Experiments, with results as precise as they are unvarying, have proved that the amalgams of potassium and sodium, formed by those powerful affinities, are negative relatively to pure metals. They present, then, the extreme limits of chemical and thermic phenomena as presented by cadmium. These phenomena will certainly be met with again in various metals of the first sections, the properties of which have been but imperfectly appreciated.

From these researches the following deductions may, in conclusion, be drawn:—

When a metal is amalgamated, its position in the scale of affinities undergoes some modification. The result may be in the contrary direction even for allied metals, for it depends both on the chemical function of the metal and on its latent heat of fusion.

If the temperature is lowered during the combination of the metal with mercury, if, consequently, the constitutional heat of the amalgam is greater than that of the metal, the latter is raised in the order of positive affinities.

When all the thermic phenomena are inverse, when heat is disengaged during the formation of the alloy, the amalgamated metal is negative, in relation to the free metal.—*Comptes-Rendus.*

Notes and Memoranda.

The resistances offered by wires of the same material to the passage of electricity in the voltaic circuit, are directly as their lengths, and inversely as the squares of their diameters. The quantity of electricity which can traverse a voltaic circuit at a given tension is therefore inversely as the length of wire, and directly as the square of its diameter.

The equivalent weight of the metal zinc is 32·5, and that of *anhydrous* sulphuric acid 40. The strongest concentrated sulphuric acid, or oil of vitriol, contains one atom of water, the equivalent weight of which is 9. 49 parts of strong sulphuric acid, when diluted with water, will therefore suffice to dissolve 32½ parts by weight of metallic zinc, forming sulphate of zinc, the composition of which is:—zinc 32·5, oxygen 8, sulphuric acid 40, and water seven equivalents, or 63.

Sulphate of copper consists of, copper 31·75 parts, by weight; oxygen 8, sulphuric acid 40, and water 36 parts, or four equivalents. When zinc is immersed in a solution of sulphate of copper, the sulphate of zinc is formed, and copper in a finely divided state is precipitated. 32·5 parts of zinc precipitate 31·75 parts of copper.

An amalgam of copper possessed of very remarkable properties is obtained as follows:—According to the degree of hardness intended to be given to the amalgam, 20, 30, or 36 parts of copper, reduced from the sulphate of the metal by means of zinc, are placed in a mortar, and moistened with concentrated sulphuric acid. To this metallic paste, 70 parts by weight, of mercury are gradually added; the mixture being stirred until a perfect amalgam is obtained. In proportion to the amount of copper will be the hardness of the amalgam when solidified. The sulphuric acid should be removed by hot water. The amalgam will then be of the consistency of wax, a condition which it preserves for some time. In ten or twelve hours, however, it becomes sufficiently hard to scratch readily tin or gold. It may again be brought to the plastic condition by heating it to about 700 Fah., and triturating in a warm iron mortar.

The sub-sulphate of mercury, employed as the exciting agent in the Marie-Davy battery, best is obtained by the action on metallic mercury of sulphuric acid, to which has been added a small proportion of nitric acid. The nitrous acid which is formed appears to take the same part

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in conveying oxygen from the air as it does in the manufacture of sulphuric acid; and, moreover, the sub-nitrate of mercury, which is very readily formed, is immediately decomposed, in presence of sulphuric acid, into the sub-sulphate.

THE chloride of zinc, formed by the action of hydrochloric acid upon the metal, is an antiseptic and disinfectant. It absorbs the sulphide of hydrogen (sulphuretted hydrogen), with formation of a sulphide of zinc. It may be economically obtained as a battery residue; a solution of salt, acidulated with hydrochloric acid being used in lieu of dilute sulphuric acid, as the exciting fluid for the positive element. The amount of "local action" upon the zinc is, however, somewhat increased. In the Daniell battery the chloride of copper may be employed in lieu of the sulphate, with the production of the chloride of zinc; but the efficiency of the battery is impaired in some degree by this substitution. Sir W. Burnett's disinfecting fluid is a solution of chloride of zinc.

INSULATION OF AËRIAL WIRES.

EXPERIMENTS ON THE INSULATION OF AËRIAL WIRES; LENGTH OF WIRES, 420 YARDS; NUMBER OF INSULATORS TO EACH WIRE, 7; HEIGHT ABOVE GROUND, 18 FEET; INSTRUMENT EMPLOYED, PELTIER'S ELECTROMETER; BATTERY POWER, 554 cells.

SUNSHINE. HYGROMETER 61°.

	Time.	Temperature.		Full Tension of Battery.	Loss of Insulation.
		Inside.	Outside.		
No. 1. Small ebonite invert - - - - -	12·29″	59°	50°	46°	None in 2′
„ 2. Large bell-shaped ebonite invert	„	„	„	„	5° in 2′
„ 3. Small ebonite, wood externally - -	„	„	„	„	None in 2′
„ 4. Do. ebonite in wood, crescent suspender - - - -	„	„	„	„	25° in 1′
„ 5. Ditto, ebonite in arm - - - - -	„	„	„	„	10° in 1′
„ 6. Earthenware terminal - - - -	„	„	„	„	46° in 4″
„ 7. Glass bell-shaped - - - -	„	„	„	„	15° in 1′
„ 8. Ditto double do.	„	„	„	„	46° in 10″
„ 9. Porcelain invert ditto - - - - -	„	„	„	„	46° in 7″
„ 10. Ditto glazed -	„	„	„	„	25° in 1′
„ 11. New ditto, French - - - -	„	„	„	„	84° in 1′

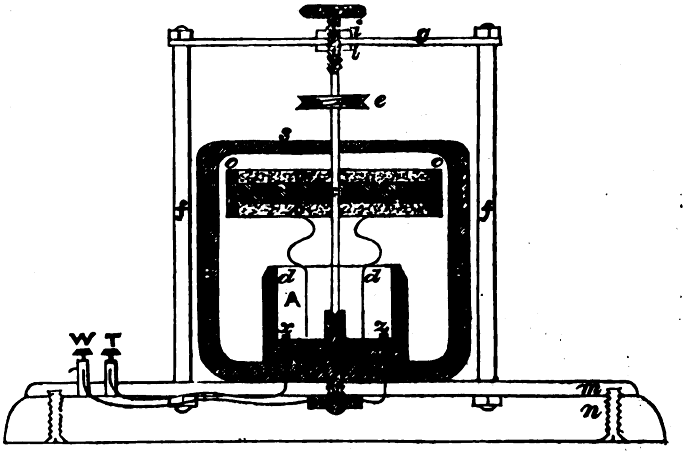
O. R.

The Student.

A CORRESPONDENT favours us with the following description of an improved form of Ritchie's rotating magnet. The principle upon which the action of the instrument depends is the attraction of the dissimilar poles, and the repulsion of the similar poles, of magnets. Thus, the north pole of the rotating temporary magnet is attracted by the south pole of the fixed magnet; but, the moment the two poles are opposite each other, the direction of the current circulating round the electro-magnet is reversed, its north pole becoming a south pole, and *vice versâ*. The movement of rotation is then continued by the magnetic repulsion of the similar poles. We may observe that the permanent and the temporary magnets should be as nearly as possible equal to each other in power, as, owing to magnetic induction, the pole of a very weak magnet is attracted by either pole of a powerful magnet:—

SIR,—To those of your students who, like myself, have not yet entered upon the deeper researches of electrical science, the following description of an electro-motive engine may be acceptable, particularly, as I have not seen any description of it in any work upon electricity, but I know it has been used long since in a modified form for making and breaking contact in the coil machine.

In the section below, A is a mercury cup, made of beech, and coated inside with a varnish made by dissolving sealing wax in naphtha; *a a* are two strips of wood ¼ inch wide, and ⅛ inch deep, glued to the bottom of the cup, so as to divide it into two equal parts. B is a permanent steel magnet of section ⅜″ × 3/16″. This is bent to the shape shown in the figure, polished and hardened, and then magnetized in the same manner as temporary magnets are made. For this purpose I used a triple coil of insulated copper wire, of about 20 Birmingham wire guage, and 6 couples of the small cast iron battery recently described by me; these arranged for quantity produced a very tolerable magnet; *b* is small brass stud, turned to fit tightly in the centre hole of the mercury cup, and passing through a hole in the middle of the magnet, and thence through the base-board *m*, the nut on its extremity being screwed up, fastens the cup and magnet securely to the base-board; at the top of the stud *b* a small conical hole is drilled to receive the lower extremity of the centre spindle *c*. C is a cylindrical core of soft iron, capped at each end with brass washers *o o*; these when polished improve the appearance of the magnet, and prevent the wire from slipping over the ends when coiling. The core C is covered with 8 coils of insulated copper wire, 18 Birmingham wire guage, as shown by D D, and the terminals *d d* are brought down, so as to dip in the mercury on each side of the division *a a* when the magnet C is fixed; when finished, the coil is coated with sealing wax varnish.



The centre spindle *c* (very economically made from a thick knitting pin), is driven tightly into a hole in the core C previously to putting the coil on the above, carries a small grooved pulley for communicating its motion to the small model it may be designed to drive. It is supported at the top by the point of a screw *h*, (which is retained in position by two light brass pillars *f f* supporting the cross-piece *g*,) fastened by the lock nuts *i i*. The pillars can be readily made of pieces of iron wire, screwed at both ends, and covered with brass ferrules made of ¼″ tube polished. These are cheap, look pretty well, and require no turning.

In the model, these pillars are placed transverse to the magnet, being drawn otherwise only for perspicuity.

X Z are copper wires, 16 wire guage, one extremity of each passing through the bottom of the mercury cup, and protruding about 1/16″ above it, and being well amalgamated, the other ends pass through and under the base-board, and are soldered to two binding screws W T, the whole is then fastened down upon the stand *n* by three screws from the bottom.

S is a soft iron armature to be placed on the poles of the permanent magnet when the machine is *not* working.

By arranging the model as above, and pouring mercury into the cup A, until level with the top of the division *a a*, the middle surface of the mercury (if pure) will be raised so that the terminals *d d* will dip into it, forming metallic contact between the magnet C, and binding screws W I, but on bringing C round to face the poles of the magnet B, the terminals then leave the mercury, and stand over the insulated division *a a*, hence contact is broken. The battery wires are now attached to the binding screws W T, and the magnet C immediately revolves.

The battery I use consists of three couples of the "nine-pin" modification, placed in the open air, and connected by wires laid as if for "bell-connections;" this is not very expensive when you do it yourself, and effectually gets rid of the "acid fume" nuisance.—I am, sir, yours respectfully,

K. R. U.

London, May 6th, 1862.

ELECTRO-MAGNETIC ENGINES.

IN 1838, Professor Jocobi, of St. Petersburg, at the expense of an imperial commission, tried the grand experiment of propelling a boat by the agency of electro-magnetism. The vessel was a ten-oared shallop, equipped with paddle wheels, to which rotatory motion was communicated by an electro-magnetic engine. The boat was 28 feet long and 7½ feet in width, and drew 2¾ feet of water. In general there were 10 or 12 persons on board, and the voyage was continued (on the Neva), during entire days. The difficulty of then managing the batteries, and the imperfect construction of the engines were sources of frequent interruption, and could not well be remedied on

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the spot. After these difficulties were in some degree removed, the professor gives as the result of his experiments, that a battery of 20 square feet of platinum will produce power equivalent to 1 horse; but he hoped to be able to obtain the same power with about half that amount of battery surface. The vessel went at the rate of *four miles* per hour, which is certainly more than was accomplished by the *first* little boat that was propelled by the power of steam. In 1839, Jacobi tried a second experiment in the same boat; the machine, which was the same as that used on the previous occasion, and which occupied little space, was worked by a battery of 64 pairs of platinum plates, each having 36 square inches of surface, and charged according to the plan of Grove with nitric and sulphuric acid. The boat, with a party of twelve or fourteen persons on board, went against the stream at the rate of three miles an hour.

Professor Page, of America, who has greatly distinguished himself by his researches in this department of science, has invented an electro-magnetic engine, the fundamental principle of which is thus described (*Silliman's American Journal*, Nov. 1850):—"It is well known that when a helix of suitable power is connected with the poles of a battery in action, an iron bar within it will remain held up by the induced magnetism, although the helix be placed in a vertical position; and if the bar be partly drawn out of the helix by the hand, it goes back with a spring when the hand lets go its hold. This power—the action of the helix upon the metallic bar within it—is the power used in Page's engine. The power, when a single coil is used, has its points of greatest and weakest force, and in this condition is objectionable. But by making the coil to consist of a series of short independent helices, which are to be brought into action successively, the metallic rod is made to pass through the coil and back again, with great rapidity, and with an equable motion. In all the engines hitherto used, there is a loss of power at the instant of the change of current, owing to the production of a secondary current, moving in the opposite direction, and to this loss is owing the fact, that these engines cannot be rendered available. Professor Page had in view the obviating of this difficulty, when he commenced his investigations. He exhibited one of his engines of between 4 and 5 horse-power, at the Smithsonian Institute, the battery to operate which was contained within the space of 3 cubic feet. It was a reciprocating engine of 2-feet stroke, and the whole, including the battery, weighed about 1 ton. Page states that the consumption of 3 lbs. of zinc a day would produce a 1-horse power. Joule's estimate is widely different; he calculates that in an electro-magnetic engine, constructed most favourably to prevent loss of power, the consumption of zinc per 24 hours to produce 1-horse power is, in a Grove's battery, 45 lbs; and in a Daniell's battery 75 lbs.

By an extended application of the force which attracts a mass of iron within an electro-magnetic helix, Hankel also attempted to produce a motive power; his investigations established the important practical law "*that this force is as the square of the power of the current.*" Fessel has also described an engine constructed on the same principle (*Bibliothèque Universelle de Genève*). His model is formed of two helices placed end to end in a horizontal position. They serve to conduct the current always in the same direction, but in such a way that it traverses alternately each of the two helices, and consequently only one at a time. In the interior of the helices is a bar of iron, which is alternately attracted from the one into the other by constantly maintaining the same polarity, and which thus executes a motion backwards and forwards. To the two extremities of the bar are fixed two slender horizontal shanks of brass, which rest upon two pulleys attached to the two extremities of the apparatus, and which thus support the whole weight of the iron. One of these shanks sets a wheel in motion; a commutator is moved by an eccentric, by means of a directing rod, which is placed so as to be able to make the machine move backwards and forwards as in steam vessels. In his later machines, Fessel has replaced the pulleys by oscillating shanks of metal rod, similar to the oscillating cylinders of steam engines.—"*Noad's Manual of Electricity.*"

PRICES CURRENT OF INSULATING MATERIALS.

Gutta Percha.

Without any stock.

India Rubber.

Fine Para ...	... ...	2s. 2d. per lb.
Negro Head	... ...	1s. 1d. to 1s. 4d. per lb.
Java ...	... ...	1s. 5d. to 1s. 6d. „

May 14, 1862.

Wm. Kirkmann,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	25 to 30	——
20	Do. B 7 per cent. till 1862 .	all	18 to 20	——
20	Do. C. „ „	all	9 to 11	——
10	London & S. of Ireland Direct.	2	par.—1 pm.	——
Stock	Electric Telegraph . .	100	99 to 101	101
25	Do. New	15	— dis.	——
5	London District Telegraph .	4¾	3¾ to 3¼ dis.	——
10	Mediterranean Extension Tel.	all	3½ to 4½	——
10	Do. 8 per cent. pref. . .	all	——	——
20	Red Sea and India Telegraph	all	18¾ to 19¼	16⅞ to 19⅛
1	Submarine Telegraph, scrip.	all	3/8 to ⅝	——
1	Do. registered . . .	all	3/8 to ⅝	——
10	Do. „ . . .	all	4 to 6	——
2	Telegraph to India . .	1	¼ dis. — par.	——
5	United Kingdom Telegraph .	2¾	1½ to 0½ dis.	——

Telegraphic News.

THE TELEGRAPH TO INDIA.

We are glad to find that the cable between Suez and Jubal is again in working condition, the fault having been discovered and repaired. It is gratifying to know that the position of a fault can be now, with facility, ascertained, hence the speedy restoration of this link in our great Indian line.

Law Intelligence.

COURT OF QUEEN'S BENCH, Westminster, May 13.

(*Sittings in Banco before Lord Chief Justice* Cockburn *and Justices* Crompton, Blackburn, *and* Mellor.)

THE QUEEN *v.* THE UNITED KINGDOM ELECTRIC TELEGRAPH COMPANY.

In this case the United Kingdom Electric Telegraph Company had been convicted upon an indictment which charged them with creating a public nuisance, by the erection of certain electric telegraph posts upon certain public highways in the county of Buckingham, and thereby obstructing the public in the use of the highways.

Mr. Bovill, Q.C., Mr. Lush, Q.C., Mr. Mills, Q.C., and Mr. Metcalf now appeared on the part of the prosecution, and moved the judgment of the Court against the Company.

Mr. O'Malley, Q.C. (with whom was Mr. D. D. Keane) applied to the Court that judgment might be deferred. He stated that the Company had become the purchasers of a patent right possessed by another company, and they had erected the electric telegraph posts and lines in question with the sanction of the local authorities. The nominal prosecutor was Baron Rothschild, but the real prosecutors were a rival company, the International and Electric Telegraph Company, and their opposition was owing to the circumstance that the United Kingdom Company had adopted the system of charging an uniform rate of 1s., which had rendered it necessary for the rival company to reduce their rates. In the first instance, the International Company had applied to the Court of Chancery for an injunction to restrain the defendants, the United Kingdom Company, from keeping up their posts and lines, but the Court of Chancery declined to interfere, but without prejudice to any proceedings at law. The present prosecution was instituted by Baron Rothschild, the nominal prosecutor, but in reality by the International Telegraph Company, not for the purpose of vindicating any public right, but with a view to put a stop to the working of the Company, whose operations had led to the reduction of their costs. The United Kingdom Company had erected their posts and lines under a misapprehension of their right to do it, which was corrected by the decision of this Court in the case of the Sheffield Gas Company. In every instance the Company, before erecting their posts and wires, had obtained the consent of the various bodies which had the care of the public highways—the local boards of health, the surveyors of highways, and commissioners—and they had erected their posts on the sides of the highways, where it was usual to deposit materials used in the repair of the roads. After the defendants' company had discovered their error, they applied to Parliament, and a Bill was introduced into the House of Lords to legalize their proceedings, and, after a hard struggle, the House of Lords had passed the Bill, which, with certain consents, would authorise what had been done.

Lord Chief Justice Cockburn said that in some counties he believed posts had been erected on the grass, by the side of the highway, to the great inconvenience of riders, who were entitled to some consideration. His Lordship asked Mr. Bovill how he could ask the Court to give judgment upon the defendants under the circumstances.

Mr. Bovill, Q.C., Mr. Lush, Q.C., and Mr. Mills, Q.C., then severally addressed the Court, and urged that there was nothing in the Bill to

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authorize what the defendants' company had done. The Bill had not yet passed the Commons, but it gave power, with the consent of certain authorities, and after certain notices, to put down posts, &c.

Lord Chief Justice COCKBURN asked the learned counsel whether he could expect the Court to assist the prosecutors in casting down the posts, when they might be set up again under the Act which was likely to pass.

Mr. Justice CROMPTON said there would be great difficulty about a writ of prostration. In the case of "Regina *v.* Wright" the sheriff prostrated a wall, but he did not know what to do with the materials, and they were ultimately built up again.

Mr. BOVILL said he must ask the Court to give the proper judgment.

After some further discussion,

Lord Chief Justice COCKBURN said the Court had power to suspend the judgment from time to time till the result of the Bill should be seen. If the Bill should pass, and the Company should fail to get the required consents, it might be incumbent upon the Court to pass judgment, but it was not so at the present time.

The other Judges concurred.—Judgment deferred.

ONE of the strangest cases of litigation that ever taxed judge, and jury, and law, has just been decided by the Lords Justices. It is strange in its incidents, strange in its alternations of fortune, strangest of all in its remarkable illustrations of the saving clauses of the new Bankruptcy Bill. Of course it is a very long story, as most suits are when they reach the decisive arbitration of the Lords Justices; but we crave the patience of our readers while we briefly narrate the circumstances out of which the proceedings arose, and the devious course they have taken.

In the year 1858, the Electric International Telegraph Company proposed to established telegraphic communication between Dunwich, in Suffolk, and Zanvoort, on the coast of Holland. The line was put up for public competition. Two respectable firms, Messrs. Glass and Elliott and Messrs. Newall and Co., both well-known manufacturers of submarine cables, competed, and the former obtained the contract. In the month of September, 1858, the cable was completed, and shipped on board the vessel employed for laying it down—the William Cory. When the William Cory was on the point of leaving port, a person named Curtis applied for an engagement to assist in laying down the cable, and, as he had been employed in a similar service in the Mediterranean, his services were accepted. The William Cory arrived at Zanvoort with Mr. Curtis on board. The cable was attached to the shore, and the work of paying out was commenced. Everything went smoothly until they had accomplished about half the distance. Then it was suddenly discovered, by means of an apparatus called a galvanometer, that one of the conducting wires—the cable consisting of four wires carried through a con-conducting substance—did not operate. As the other three wires retained their conducting power, the rest of the cable was, however, payed out, and ultimately communication was established between Dunwich and Zanvoort; but the damaged wire remained perfectly useless. The contractors then set about fishing up the cable, and after having taken up about two miles of it they discocovered the portion in which the imperfection rested, cut it off, and sent it to the directors of the company. This was stripped of its covering, and it was found that a piece of a nail had been pushed into the wire, thereby acting as a conductor, and rendering the wire useless. On being pressed, the man Curtis confessed that he had intentionally driven the nail in, and then sawed the head off to avoid discovery, at the instigation of a Mr. Boswall, manager of the business of the rival contractors, Messrs. Newall and Co. It seems that two years previously there had been some litigation between the two firms, as to the alleged infringement of a patent of Messrs. Glass and Co., and that Mr. Boswall, suspecting the successful contractors of using his patent, employed Curtis as his own agent to report upon Messrs. Glass and Elliott's cable; the worthy Mr. Curtis drawing one guinea a week from Messrs. Glass and Elliott, and 33s. a week from Messrs. Newall. According to Mr. Boswall's statement, his only duty was to act as a spy. Curtis himself swore positively that, "Boswall asked if there was a possibility of driving a nail into the cable, and explained to him how he could do it between the wires, and told him it would be as good as £1,000 to him if he did it." Hence the action against Mr. Boswall. The jury believed Curtis's statement, and found for the plaintiff, Messrs. Glass and Elliott. An award was made for £3,875 1s. 10d., exclusive of costs. Mr. Boswall immediately became bankrupt on his own petition. That was in the month of December, 1861. The bankrupt's debts were under £150, irrespectively of the award; his assets amounted to £300. On the 4th March last the bankrupt was discharged, the commissioner deciding that the bankrupt had not been guilty of any offence constituting a misdemeanour under the act of 1861.

From this decision Messrs. Glass and Elliott appealed, and final judgment was given on the 6th inst.; the Lords Justices sustaining the decision of the commissioner. The practical result of this is, that the bankrupt gets off scot free; and that, so far from recovering any portion of the £3,875 awarded to them, Messrs. Glass and Elliott will have a considerable bill to pay in the shape of law expenses. The case is a peculiarly hard one. A jury had distinctly backed the justice of Messrs. Glass and Elliott's claims. Mr. Boswall's application for a new trial was refused. But, thanks to Lord Westbury, there was an Alsatia open to him in Basinghall-street; and he now, with some scores of co-respondents, who have similarly availed themselves of its privileges, defies the terrors of the law and the wrath of his enemies. We do not see how any other decision could have been arrived at in the existing state of the law. The conduct of the bankrupt could not be brought within the meaning of the 159th section; and the sections in former acts by which he would have been liable to a suspension or a refusal of his discharge have been repealed by the act of 1861. At the same time, on the verdict of the jury, it is clear that the debt grew out of a demand for a malicious injury, and it is a manifest omission in the present law of bankruptcy that no provision has been made for dealing with such a contingency. Lord Justice Knight Bruce threw out a hint, in the course of the proceedings, for an amendment of the 159th section in this direction, and we trust it will not be lost sight of.

The truth is, scarcely a week arises that does not bring out some new defect in Lord Westbury's Bill. The indecent haste with which it was pushed through Parliament gave no opportunity for the consideration the subject required; and we now find it a crude and imperfect piece of legislation, entailing all sorts of inconveniences and wrongs upon the public. The case to which we are now referring is by no means a singular instance, yet it is one which, of itself, demands some alteration in the law. It never could have been intended that the ends of justice should have been so completely frustrated; and the carelessness that perpetuates this result of mere oversight inflicts an injury on the honest portion o the community. Is it too much to expect that Lord Westbury will condescend to admit his error and devise a remedy?

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

SIR,—I must beg to thank you for the liberal way in which you have acknowledged, that the plan I have proposed for laying submarine cables, has been better abused than understood. I feel confident, with the support of scientific seamen which I have obtained, that the thing will answer; and I will respond at once to the objection which you speak of as to the influence of the dependent weight of the cable, by saying that it would take a weight of no less than five tons at ten feet from the centre, to deflect the cylinder half a degree, when it was unloaded, in which condition its draught of water would be four feet only, and would, therefore, present the most unfavourable condition for stability. If those who entertain such doubts would only, by expressing them openly, enable me to give the answer which is required, and which my studies on the subject would, I hope, enable me to do, no such prejudice as now unfortunately exists, would be permitted longer to interfere with the acknowledgement of truth, or the detection of error. M. SELWYN, CAPT. R.N.

To the Editor of THE ELECTRICIAN.

SIR,—I read with some surprise in this morning's papers, the report of the pressing for judgment on the part of the Electric and International Telegraph Company against the United Kingdom Telegraph Company.

As a lover of fair play and free trade, I cannot but feel much disgusted with the vindictive spirit shown by the former company, which even attracted the observation of the Lord Chief Justice. I have no interest whatever in any telegraph company beyond getting my messages forwarded to their destination with rapidity and accuracy, and so far I have found the new company the best in both of these requisites.

Of the value of the reduction in rates, it is needless to speak; as any course calculated to put the general public in possession of the advantages offered by such a scientific discovery as the electric telegraph, is deserving of high commendation, and there is no doubt that were the United Kingdom Company to "come to grief," the rates would at once go up again to the old four shilling scale. It seems to me to be a great sign of weakness on the part of the competing companies that they should thus strive to put down a competitor—surely there is room for all. It seems that the Bill of the United Kingdom Company has passed the Lords, and it is to be hoped, in the interests of justice, that it will also pass the Commons—depend upon it there is nothing like fair, open, competition in every thing.—I am, yours &c., FREE TRADE, AND NO MONOPOLY.

14th May, 1862.

To the Editor of THE ELECTRICIAN.

SIR,—Can you kindly inform me as to the best way of magnetizing a small steel horse-shoe, for the interior of the coil of a telegraphic instrument? I have magnetized a couple by stroking the ends alternately over the alternate poles of an electro magnet, but I can't get them strong; they require much more battery power to deflect than should, I think, be required, say three pint cells of Smee's (1-10 acid), through about 300 feet wire. Any information on this subject will much oblige.—Yours obediently,

A. H. B.

[Perhaps the best plan would be to coil the steel horse-shoe as an electro-magnet, and to transmit through the wire a current from a powerful battery.—ED. E.]

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OCEAN TELEGRAPHY.

To the Editor of The Electrician.

Sir,—I observe in your impression of this day, a reply to a letter which appeared in the *Times* last week from a correspondent signing himself, "Anglo-Americanus."

I have no knowledge of the precise experiments referred to by the writer, but there does not appear to be much difference of opinion among scientific and practised telegraphists, as to the law of the squares governing and limiting the speed of operating through long cables. The law may not be absolutely correct, and, like the mariner's compass, there may be a deviation, and an undefined law governing the variation of the deviation. Yet the "deviation" and the "variation" are sufficiently known for commercial purposes. With respect to submarine cables, we know there is a retardation, and experts engaged in the science and art of subaqueous telegraphy have found that the manifestation of the inductive influence was, as near as can be determined, according to the square of the distance.

The following short extracts from the "Blue Book," on submarine telegraphy, will show the views held by some of those who have had considerable experience in long telegraphic lines. In the evidence before the Commissioners, p. 142, Mr. Fleeming Jenkin, speaking of the working effects requisite through a cable, in order to produce observable results, says:—

"I am certain that that limit is in various lengths of cable, as the square of those lengths. The amplitudes, I find, when they are reduced to the same strength of maximum current, are in sufficient lengths precisely as the squares of the length."

Professor Thomson, after explaining his views on the subject, says:—"If, then, we can get 3 words a minute through 2,000 miles, for example, through 200 miles there would be 300 words a minute possible; and I say that 300 words a minute are possible." He then proceeds to explain the obstacles to working by hand at this rate, and alludes to mechanical contrivances for operating upon such a line.

Mr. Siemens says:—"If the cable is very extended in length, without increasing either the conductor or the insulating covering; or, in other words, if the cost is the same, the power of speaking through this cable will decrease very much in the square ratio of its length."

Mr. Varley, after describing instruments used by him to ascertain if the law of the squares of distances was correct, and the corroborative results which he obtained, was asked by Mr. Clark, whether it was as the square exactly? to which he replied in the affirmative.

The foregoing extracts express very clearly the decided views entertained by those gentlemen; and the opinions of other eminent telegraphic authorities might be given from various works to the same effect.

I conceive that the point at issue is of the gravest importance to the electrical world, and that the result of enquiry will go to establish even more firmly the great advantage; in fact, the necessity of dividing all lines of great length into a series of short sections, whenever it can be done by any possible means.—Very respectfully,

Tal. P. Shaffner.

49, *Weymouth Street, Portland Place, W., May 10th*, 1862,

TESTING IN VACUO AND UNDER HYDRAULIC PRESSURE.

To the Editor of The Electrician.

Sir,—Your correspondent, "A Telegraphist," should have added in his letter upon the above subject, that although it is considered necessary to test the cores in mile lengths in vacuo and under hydraulic pressure for the *detection of faults* (?) it is not thought desirable to submit the *joints* to such test. It is well known that more failures have been traced to *defective* joints than to the insulating material.—Yours, &c.

13th May. Neptune.

TELEGRAPHIC DELAYS.

To the Editor of The Electrician.

Sir,—People ought not to have cause to complain of delays in the despatch of telegraph communication. A gentleman, the other day, ordered a fly to be in readiness for him at a railway station at some distance from the place of transmission of the message, but he arrived at the appointed station ten minutes before his telegram! Another gentleman, a friend of mine, told me that he was certain he could have gone to the place for which his message was destined, and *back again*, much quicker than his telegram actually accomplished one-half of the entire distance. How are these complaints to be accounted for and redressed? If by *bells* at every station, by all means let us proclaim the reign of bells! As things are, many are disaffected towards the existing dynasty in which the needle oscillates unseen on its pivot throne behind a tall screen, but far too slowly effectuates the wishes of its millions of subjects.—I remain, dear sir, yours very truly, L. L. S.

TELEGRAPHY AND THE INSTITUTION OF CIVIL ENGINEERS.

To the Editor of The Electrician.

Sir,—At the Institution of Civil Engineers on the 13th inst., a paper was read by Mr. Forde (the late Mr. Lionel Gisborne's partner), on the laying of the Malta and Alexandria Submarine Cable. I was very much surprised to learn for the first time that it owed its successful submersion to the skill and ability of the *Government Engineers and Electricians*, so often referred to by Mr. Forde in his paper.—I am, sir, your obedient servant, Detector.

POLE INSULATORS.

To the Editor of The Electrician.

Dear Sir,—I have with pleasure read in different numbers of The Electrician many practical articles on subjects requiring ventilation, and believing you interested in anything new in the useful materials for the telegraphist, I beg to hand you for your inspection a couple of insulators of my own manufacture, and I flatter myself that on putting them to the severest possible tests, you will form an exceedingly favourable opinion of their perfection.

I have tried them under many disadvantages, and with the French and other insulators, and in all cases found them vastly superior; they will be found to take a high charge, and more than that, to retain it, and from their behaviour when exposed to wet, and even steam, under the bell, I conclude they will work as efficiently in the heaviest fog as in the driest of atmospheres.

You will perhaps favour me with your opinion.—Yours faithfully,

Imperial Potteries, Lambeth, May 13th, 1862. John Cliff & Co.

[The insulators in question retain a charge of 70°, equivalent on our instrument to that from 1,000 Daniell cells, losing less than 2° in 20 minutes. They were not affected to any very evident extent by exposure during 15 minutes to air saturated with the vapour of water. We may safely say that we have never tested a better insulator than the specimens received.—Ed. E.]

Miscellanea.

Marine Glue.—This cement is made according to the following recipe:—Take one pound of india rubber, cut it into small pieces and dissolve it in about four gallons of coal-tar naptha; the mixture being well stirred for some time till perfect solution has taken place. After ten or twelve days, when the liquid has acquired the consistence of cream, two parts by weight of shellac are added to one of the liquid. This mixture is put into an iron vessel having a discharge pipe at the bottom, and heat applied, the whole being kept well stirred. The liquid which flows out of the pipe is spread upon slabs and preserved in the form of plates. When required for use, it is heated in an iron pot to about 248 Far., and applied hot with a brush.

Science a Civilizer.—Dr. J. Bullar at a recent meeting of the Southampton Microscopical Society, said:—"The social aspect of our Society commends it. It is a pleasant way of spending an evening where there is a scientific object of natural interest, and, at the same time, a social gathering of many having the same tastes and objects, and, therefore, the same sympathies. The anatomy of an insect, too, is a more harmless occupation than the minute dissection of a neighbour's natural history. Tea and coffee, pleasant chat with those of like tastes, and then the table covered with microscopes and specimens explained by one, and passed round for each one to examine, calling out animated talk on subjects worth discussing, or a short paper read and discussed on the subject illustrated, are civilizing. For science is a civilizer. It refines the tastes and elevates the thoughts, as it is the search after truth for truth's own sake. And in this age, when the progress of the nation and of the world is estimated by the money value of exports and imports (and in this respect the world's progress is prodigious and annually increasing), the danger must lie in estimating all things in reference to money rather than to truth. Now, science is a counteracting force. It neither brings wealth to its true cultivators, nor can wealth buy scientific tastes or scientific fame. It belongs to a higher region than 'the diggings.' It must breathe 'a purer ether, a diviner air.' And those who are engrossed in commerce would often do well, for their own content and happiness, by seeking in the recreations of science a complete change of action, thought, and feeling. Obviously the eye service which the microscope requires, trains the eye to minute and discriminative observation, and the hand to delicate accuracy. It leads on, if used scientifically, to the improvement of scientific powers. The memory, the investigation of causes, the estimation of evidence, the power of distinguishing and of generalizing may be called into activity. But the mind has other and deeper needs than these. The senses lead to the awakening and culture of deeper powers inherent in the soul itself, and the microscope may excite and cultivate, not only the sense of the true, but of the beautiful. Constable, the landscape-painter, said that, pictorially, nothing in nature was ugly; and surely we may say the same microscopically. The higher the magnifying powers, the more minutely extensive the investigations, the more beauty do we see. Even in the unhealthy secretions—in what look to the unscientific eye like repulsive fluids, in the very disorganations which slowly ruin this goodly human frame, the microscope discovers forms of the highest geometrical accuracy, as well as of the most delicate beauty. And this beauty and consummate finish are everywhere, and are found farther and deeper as our powers increase of observing them. Here, too, at every step we find the limitation of our own powers, and the illimitable field of nature: the infinite contrasting with the finite, teaching us 'the moral lesson of science—humility.'"

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The Electrician.

VOL. II. No. 29.—MAY 23, 1862.

CONTENTS:

	PAGE		PAGE
Steps to Theory by the Practice of Electricity	25	The Nail in the Cable	32
Elementary Data for Manufacturers	26	A New Projectile Force	33
Some Considerations on the Principles of Electrical Conduction and Accumulation	27	International Exhibition	34
Visit of the Officers of the Japanese Mission to the Electric and International Telegraph Company	29	The Student	35
Professor Hughes' Electric Telegraph Apparatus for Printing in Roman Type	30	Prices Current of Insulating Materials	35
		Telegraph Shares	36
		Colonial and Foreign Telegraphy	36
		Recent Patents	36
		Telegraphic News	36
		Correspondence	36
		To Correspondents	36

STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 13.]

212. THE telegraphist must be conscious that of all electricians he just now most needs to acquire new light. For his undertaking to prosper on the large scale to which he is in every direction extending his endeavours, it is of vital importance that the electricity he communicates to the near extremity of his conductor shall, without occupying sensible time in its transit, all find its way to the other extremity; but he knows, from having watched the habits of his messenger, that though it be winged with lightning it can loiter on its errand, prone at every momentary cessation of his bidding to return upon its course and vex him by its presence. He knows, too, that like the "Ariel" forced into human service by the wizard "Prospero," it longs for the term of its captivity to expire, and, more subtle than the sprite, finds for itself a freedom before it can well be spared. And what leading is there for the telgraphic engineer to follow, by which he may hope to arrive at a more complete mastery over the powerful element he is essaying to command? Is he a practical worker? the improvements suggested to him by hard and expensive experience are not yet fundamental enough for his purpose, for they have taught him nothing of originating electrical causation. Is he a scientific electrician? then he may have improved and added to the number of his *rules of thumb*, and thus have become an authority among his compeers, but he will not have put the science upon a better foundation. Is he a mathematician? if so he may have facilitated his practice by availing himself of the *laws of circumstance*, that mathematical observers before him have deduced from by-gone experience. But in neither character, nor in all three combined, can he expect to soar above the beaten track, even though he take the lead in it, *until he have acquired a perception of originating electrical causation*—of the intimate normal relation that electricity bears to common matter; for it is by that, and that alone, he can enter upon his onerous and costly enterprises with any certainty of converting them into safe and remunerative investments of capital. When he shall have achieved that knowledge, and not until then, will he be surely able to separate the good from the evil of his appliances, and to avail himself of all the advantages offered by the one, without entailing upon them the drawbacks inflicted by the other.

213. We are no obstructionists to ocean telegraphy; on the contrary, while we believe that the way to promote it is not to attempt it blindly, we are at the same time well assured that its extension may immediately be made with eminent success, provided only that advantage be taken of the progress in electrical knowledge that has lately been made. If the limited electrical attraction which hitherto has served us so well, has its foundation resting upon the firm basis of physical truth, as we cannot but believe, it will need only to be applied in a competent manner to the subject of telegraphy for all its professors to be put into possession of what they require; and although we are attempting this application in our own popular manner, we feel it is a work in which the inductive reasoner and the mathematical demonstrator might well combine to engage in. We speak unreservedly on this matter, prompted equally by the confidence which has resulted to us from a long experience of what we believe to be originating electrical causation, and by the pressing calls made by the present position of ocean telegraphy; and trusting that our assurance will be justified by the elucidation already given in these pages of a hitherto impracticable branch of electrical science, that is known to extend itself as the substratum upon which telegraphy, as now practised, mainly rests. The nature and laws of electricity, as we have applied them to induction acting from the surfaces of charged conductors generally, we are now ready to show may be applied with equal effect to the telegraphic wire and cables of every present construction.

214. We could have wished, on entering on our present task, that our demonstrations had already comprised much more than we have had time to tell; that we had amongst other things explained how electricity may, on mechanical principles, attach itself as a plus charge to common matter in its normal electrical condition, that is to say, in larger quantity than the common matter can attract; and that we had traced our definite electrical attraction down to the conducting property of matter. Our electrical system professes to be as complete in those particulars as in former ones; but in a true system, so intimately dependent is every part upon all the rest, that all need to be generally known before any one can be thoroughly comprehended. We must submit to labour under this disadvantage in what we are about to say, for we must base our arguments, to a certain extent, upon a view of the construction of matter of which we have advanced no proofs; but if we assume nothing that is not consistent with all in natural philosophy that we are acquainted with, we may reasonably ask that our view be temporarily entertained while we endeavour to show its competency to do whatever may be required of it; and if it prove fully competent, it must, of course, be thenceforward regarded as an established doctrine.

215. What we have to assume in the present instance is, that the material electricity that we see, feel, and know to be moving in things around us, is made up of minutely small particles that are unsusceptible of any further division; electricity being in that respect analogous to all the other kinds of matter. The truth of this doctrine may be held in doubt, and we care not if it be so; it will be sufficient for our purpose if those we are addressing admit it to be possible, while we show how much it can do in throwing light upon the electrical telegraph. Whether true or untrue, it will then have made its competency understood; after which we may leave the question of its adoption to the reader's sagacity.

216. Our theory of the definite character of electrical attraction and of its consequence—the inductive action that starts into immediate existence on the slightest derangement of the normal electrical distribution—teaches us to consider the wire of the electrical telegraph, even in its most simple form, under two perfectly distinct aspects; it seems always to have been constructed for performing two different functions, not generally known to be separable from one another, either in theory or in practice. The causation in both cases has been too profound to be understood; and that being unknown the functions themselves, and therefore the conditions on which they depend, have been more or less confounded together. It is to that circumstance that we mainly attribute the difficulty which has attended the experimental investigation of telegraphy, the conflicting nature of the evidence adduced for its elucidation, and, consequently, the little good that has hitherto resulted from an abundance of past observation. We shall endeavour to separate those functions, developing their conditions, and pointing out their respective characters and importance.

217. In both the cases, electrical conduction, as well as electrical charge, distinct though they be when considered as results, there is in operation, for attaching plus electricity to neutral matter, a cause that we have not yet made known; it cannot in

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this place be adequately treated, but still we must not pass it over without giving our readers such a preliminary conception of it as will enable them to perceive its perfect consistency with the acknowledged principles of mechanical philosophy. We may imagine a spherical particle of common matter to have a portion of its surface occupied by comparatively minute particles of electricity attracted towards its centre as *part of its natural electrical equivalent;* then three things will become evident, first, that the particular particle of common matter will have room to receive upon its surface some additional number of electrical particles; second, that that particle, *without attracting a larger total quantity* of electricity, can attach to its surface an additional number of electrical particles, if placed upon it, because some part of every one that will be so placed must be nearer to the common centre of attraction than all the parts of any one of them. Under these circumstances the parts that are nearest, making up in their total a quantity required to complete the electrical equivalent, will be held by attraction; the remaining parts, not attracted by the common centre, will be attached to the particle of matter, by the indivisibility of the particles, and be to it a plus charge. The third thing that will become evident, is that as many particles of electricity as shall be so placed on one side of the surface of a common particle in addition to its natural equivalent, may, if an adequate removing cause be in operation, be taken from it at the same or any other side without the particle of matter losing its normal quantity.

218. Here it may be remarked that we are not explaining by what means the additional particles of which we have spoken can be either placed upon, or subsequently removed from, the partially vacant surface; but we shall come to these explanations presently.

219. Now, apart from the consideration of all surrounding circumstances, the electrical condition of the particle of common matter that we have just described, may be the condition of all the particles throughout the whole substance of a conductor, in its interior as well as its exterior parts; if, then, in practice we find the condition to be at any time limited to any particular part of a conductor, we must conclude that its locality is alone determined by surrounding circumstances for the time being.

220. It will be seen that what we are now saying about the power of common matter to receive and attach to itself electricity in excess, is consistent with the definite electrical attraction upon which we have founded our whole theory, a doctrine which up to the present moment we have been enabled to maintain in all its integrity. We have incessantly taught that no conductor can appropriate to itself absolutely a single particle of plus electricity, common matter universally having had assigned to it at its creation a particular and unchangeable quantity, so that any additional particle that may be placed upon it, it can only hold, as it were, in trust for some rightful owner. We have shown, too, on what conditions it can hold it, lulled into a temporary condition of peacefulness, by what we have called the *artificial electrical equilibrium;* it is to be supposed that our readers know what we mean by that expression, as we have so often exemplified it by the resolving of old mysteries, but nevertheless it may be as well that we occupy a few minutes in recapitulating its principal features.

221. The artificial electrical equilibrium is that state of matter which becomes established whenever plus electricity, exerting attraction for its equivalent of common matter, from which it is temporarily separated, acts upon surrounding non-conducting neutral particles, *virtually*, though by reason of their insulating nature not *actually*, dismissing from them some of their natural electricity; and causing the same action to be propagated to progressively increasing quantities of insulating matter, until, by reason of the electrical law of the squares of the quantities, the intensity becomes so reduced as to be insensible on our most delicate instruments. This, the ordinary form of artificial electrical equilibrium, is sometimes somewhat modified by the intervention of neutral conducting matter, which if it be near enough to sustain the induction can *actually* as well as *virtually* relinquish a portion of its own electricity, and thus promote the reduction of intensity (par. 124), especially if the electricity relinquished can pass into earth, from the surface of which it can act inductively with an intensity that may be regarded as infinitely small (par. 138). As the facilities for the reduction of intensity increase, so will of course the charging capacities or quantities of plus electricity susceptible of being held under any specified intensity; and owing to this law, if a conducting surface have contiguous to it another conducting surface communicating with the earth, it can receive upon it under a given intensity far larger quantities of charge than when it is simply surrounded by air (par. 56, *et seq.*, Exp. 22, par. 137, *et seq.*).

222. Considering then that the distance at which the electrical attraction may be acting between a common particle and its electrical equivalent is shortened by an accession of plus electricity, and that plus electricity on the surfaces of common particles can have the intensity of its attraction reduced to an insensible amount by induction, we can understand plus charge to be both possible and in perfect harmony with the doctrine of limited electrical attractions.

223. Now when we lay an insulated wire between two distant places, and deliver electricity continually into one of its extremities with greater rapidity than it can find its way out of the further extremity, put to earth, it is impossible not to charge its surface, and that charge may have an intensity of action to any amount, not exceeding that of the source from which the plus electricity is delivered. This is true whether the further end of the wire be freely uninsulated or insulated. We cannot surround a long conductor with a cylindrical vacuum of diameter large enough to put common matter beyond the reach of induction, or we might establish a telegraph wire with the *ne plus ultra* of perfection; for under such circumstances electricity would either not enter the wire at all, or only do so in order to arrive through it at some charging capacity at the other end, capable of holding it under an intensity below that of the source. At the best, our telegraphic wire has a very sensible capacity for charge, derived from the air around it; and even this degree of imperfection is always necessarily abandoned for a worse whenever the circumstances of our locality constrain us to convert our naked wires into "cables," for the purpose of their interment or submersion; for in either of those cases the solid insulating materials by which the wires are enveloped for maintaining their charge is far too thin to keep the external conducting matter at an effectual distance, and thereby preventing it from dismissing by induction comparatively large quantities of electricity to find on the surface of the earth or sea a lower intensity of charge than could otherwise be afforded. The greater charging capacities thus occasioned are known practically to give rise to evils of enormous magnitude, and of which every telegraphist is sufficiently sensible and deprecatory.

We had intended in this issue to have reached on to the laws of electrical conduction; but we find in order not to tire our readers that we must postpone them until next week.

(To be continued.)

ELEMENTARY DATA FOR MANUFACTURERS.

HOWEVER valuable in the abstract may be the compendious Blue Book containing the Report of the Committee appointed to investigate the facts relating to submarine telegraphy, it is doubtful whether it is read with any degree of profit by a large class of those on whose opinions and practice depends, to a great extent, the progress of this branch of electrical science. Several manufacturers—men of sound practical knowledge and experience in their own particular sphere of industry, complain that the Report in question, which they would fain adopt as a

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standard of reference, does not afford such clear and unmistakeable data as are necessary for a guide to practice. To use the expression of one of those manufacturers, "It does not explain what is wanted in telegraphy—what should be aimed at to obtain a perfect cable, and it mystifies by alternately blowing hot and cold in the same direction." Of course, it must be allowed that the fault, if any, does not rest wholly with those whose labours contributed to a report which was mainly intended to benefit telegraphy through the telegraph engineer. "Blowing hot and cold" may simply mean giving fairly the two sides of a question. Again, the want of clearness may probably be traced to the absence of information respecting the precise meaning of the terms employed. But such information, however desirable, certainly cannot be expected from a Blue Book, in such a form as to give the key to its contents. Unfortunately, it has not been readily obtainable in any other quarter. There is no catechism of telegraphy, and the vocabulary of the ordinary hand books of electrical science is scarcely available for the information in question. It is now, however, our task to supply, if possible, what is wanting, and to point out in what direction manufacturers may best employ their energies to secure for themselves a deserved recognition, and for ocean telegraphy permanent success and rapid extension.

Duly considering the questions of efficiency and of economy, the manufacturer will readily understand how the two antagonistic principles will modify each other, according to circumstances. A short length of cable of the same construction as the one intended to traverse the Atlantic, would, in a pecuniary point of view, scarcely be the best to adopt for a line of one hundred miles or less. On the other hand, a cable so constructed as to answer perfectly all the requirements for a short line would not be equally efficient for a greater length. On a short line the requisite amount of insulation has alone to be obtained in coating the wire; on a greater length, the insulating covering has to be increased in thickness in order to diminish the inductive action which occasions retardation of the signals. On the subject of this *induction*, we have a few words to say, which may contribute to remove a misunderstanding which we have found very prevalent amongst those who have consulted the Government Report, with the object of basing their manufacturing operations upon the conclusions therein arrived at.

The term *absorption* has occasionally been used to signify the same thing as *induction*. From this it has been concluded that that induction is an absorption of electricity by the insulating medium, occasioned by a greater or less degree of *porosity* in the latter. This erroneous conclusion, to which we have referred in a former number, has been strengthened by the statement, contained in the Report—that the greater the insulating capacity of the material, the less will be its inductive effect. This, by the way, is true only in regard to a few substances which have been used as insulators for submarine wires. What is termed induction or absorption, is the accumulation of electricities of opposite character on the surface of the insulator in contact with the wire and on the surface in contact with the surrounding conductor, viz., earth or water. Thus, a length of insulated wire, without its external metallic covering, simply coiled upon the floor, or the same length suspended in air, will show no appreciable effects of induction—will not take a charge, and will occasion no retardation in the transmission of signals.

It is evident therefore that the retardation of signals, which is due to the accumulation of electricity in the wire is not occasioned by "absorption" into the "pores" of the insulating material.

When we increase the thickness of the insulating coating, we decrease the amount of induction by diminishing the facilities for the accumulation of the opposite electricities on either surface of the insulator, or by "increasing the inductive resistance,"—not by increasing the degree of insulation, and thereby preventing leakage of "absorbed" electricity. We wish to render it perfectly clear that the questions of insulation and induction are to be considered independently of each other. A wire may be very perfectly insulated, and yet be deficient as a submarine conductor by reason of high inductive capacity. Or, it may occasion but a small amount of retardation in working, and be very defective in regard to insulation.

Where insulation alone has to be considered, as in the manufacture of short lengths of cable, a comparatively small thickness of insulating material is sufficient, providing its permanency can be secured. Beyond this extent the insulation should not, from motives of economy, be increased, unless with some object in view. Telegraph contractors have frequently complained, with some show of reason, of the increased cost per mile of telegraph cores, consequent upon improved insulation beyond the degree which is necessary for the economical working and permanence of short submarine lines. It may be held that the increased security in regard to the permanence of the insulation obtained by augmenting the thickness of the coating, is well worth some additional expense, even in short lengths of cable. This is true only insomuch as the increased number of layers of the material renders more difficult the occurrence of a fault, which, however small at first, might speedily be increased by the action of the voltaic current. But the *necessary* thickness of insulation should be applied in a number of layers, so as to avoid the chance of a fault arising from defective portions in two or more of the layers being immediately superposed. Professor HUGHES has satisfactorily shown that voltaic currents exert no mechanical force whatever upon the insulating coating of a conducting wire. If there be a defect in the coating, extending to the wire, it may be enlarged by the current; but if there be no fault through which the current can first commence its work of destruction, no voltaic current would exert sufficient force to tear a piece of paper.

To obviate the effects of induction in long telegraph lines, where the charge and discharge of the wire interfere materially with the speed of transmission, the inductive resistance should be increased by augmenting the thickness of the coating of dielectric to an extent dependent upon its "specific inductive capacity." It is a common mistake to suppose that the object of a thick covering is simply to improve the insulation. A length of wire might be insulated so perfectly as to retain for a considerable period a charge on the electrometer, and yet be useless on account of its capacity for charge. It has even been maintained that a low inductive capacity, and a comparatively low degree of insulation should be aimed at in the construction of long submarine cables. The grounds for this opinion appear to be that the *discharge* of the cable may be effected to a great extent by the neutralization, though the insulating medium, of the opposite electricities accumulated upon the two surfaces. It is evident that the discharge of the wire might be facilitated by the low insulating capacity of the dielectric; but it is evident also that the time required to charge the wire would, in the same ratio at least, be increased. In the present system of working submarine lines, it is necessary fully to charge the wire before a signal can be transmitted, and in the construction of such cables the manufacturer may confidently, as far as our present experience goes, aim at the highest insulating capacity, as well as at the lowest capacity for induction.

It may ultimately be found, in practice as in theory, that insulation is the only essential condition to be obtained in covering submarine conductors; but, until this is established, the data we have given will apply to the working of such conductors under the ordinary system.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 17.]

WE have thus far confined our attention to considerations as to the proportionate quantity of electricity that would be generated

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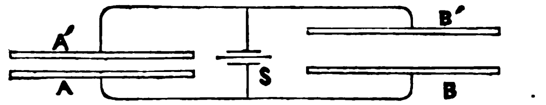
from a given constant source under various conditions of the insulated conductors in connection with the source, and to the distribution of the electricity so generated on those conductors. We have now to consider *the distribution of the electricity generated when an alteration in the conditions of the conductors takes place after the source has been withdrawn;* or, in fact, to consider *the distribution of a given quantity of electricity under different circumstances.*

It has been stated that in any branch circuit the quantity generated at one side of a source will divide itself in the inverse ratio to the inductive resistances constituting the two branches of the inductive circuit thus formed. Suppose now A A′, and B B′, (fig. 57), to represent two sets of plates of equal size, the plates

Fig. 57.



B B′ being separated from one another twice the distance that A A′ are separated. Then a certain quantity, Q, will be generated and divided between the plates inversely as their inductive resistance, or supposing $Q=1$, $\frac{2}{3}$ on A and $\frac{1}{3}$ on B B′. Now if the source S be withdrawn, the distribution on A A′ and B B′ will remain unaltered. This distribution of the quantity Q, on the plates A A′ and B B′, when in that position, is therefore the distribution which under those conditions produces equilibrium. If the quantity Q had been communicated to two sets of plates when in some other position than that shown, it is evident that when the plates are placed back into their first position, as shown in the figure, the same distribution must ensue, or else the conditions of equilibrium would not be fulfilled. If, for instance, when the plates A A′ were separated a distance equal to the distance separating B B′, a quantity equal to Q were imparted to them by some source S′, acting with greater electrical energy than the previous source S, then if the source be withdrawn and the plates replaced in their original position, the quantity Q on them being the same, and their position the same as at first, the distribution must be the same; but this distribution was inversely as the inductive resistance between the plates, and therefore the quantity Q, although communicated to them when in some other position, has divided itself inversely as the inductive resistance between the surfaces in their new position. In the same way, it may be shown that any quantity whatsoever communicated to two sets of surfaces, will distribute itself inversely as the inductive resistance, separating those surfaces from their opposing surfaces.

Now, when the quantity Q was communicated to the two plates, by the source S′, in their second position, the quantity and density on the plates A A′, B B′ were equal, or the quantity on A A′ equalled $\frac{1}{2}$, and on B B′ $\frac{1}{2}$, when replaced in their first position the distribution would be $\frac{2}{3}$ on A A′, and $\frac{1}{3}$ on B B′, the quantity on the plates A A′ has been increased therefore by a decrease on the plates B B′.

The quantity generated at one pole of a source will, therefore, divide itself on the surfaces which it charges, in the inverse ratio to the inductive resistance separating those surfaces from the opposing surface, to which the other pole is connected. And when two surfaces are charged, and the source removed, then, if any alteration take place in the position of those surfaces, a redistribution of the charge will take place, and the charge will redistribute itself in the inverse ratio to the new resistances.

If, instead of two surfaces there be three or more, separated from the opposing surface by as many resistances, the distribution will in the same way take place in the inverse ratio to the resistances.

And in the same way, therefore, if a single surface be alone charged with a given quantity, and then brought into contact with other surfaces insulated from opposing surfaces which are in connection with the surface opposing the charged surface, a redistribution will take place, and the quantity will redistribute itself between the several surfaces in the inverse ratio to the resistances separating those surfaces from their common opposing surface.

Thus, suppose three Leyden jars, A, B, and C, of different inductive resistances; then, if the jar A be charged with a certain quantity Q, and after being removed from the source, its interior be placed in contact with the interior of B and C, whilst the exteriors of the three jars are in conductive connection, the quantity Q will redistribute itself over the three interior surfaces, a corresponding change taking place in the opposing charge of contrary name on the exteriors. If a, b, and c represent the inductive resistance of the three jars respectively, and q, q', q'', the quantities respectively in each after the redistribution then:

$$q : q' :: b : a \therefore q' = \frac{q\,a}{b},$$

$$\text{and } q : q'' :: c : a \therefore q'' = \frac{q\,a}{c},$$

$$\text{Now } Q = q + q' + q'',$$

$$\therefore Q = q + \frac{q\,a}{b} + \frac{q\,a}{c},$$

$$\therefore b\,c\,Q = b\,c\,q + a\,c\,q + a\,b\,q = (b\,c + a\,c + a\,b)\,q,$$

$$\therefore q = \frac{b\,c\,Q}{(a\,b + a\,c + b\,c)},$$

$$\text{and } q' = \frac{a\,q}{b} = \frac{a\,b\,c\,Q}{b\,(a\,b + a\,c + b\,c)} = \frac{a\,c\,Q}{a\,b + a\,c + b\,c},$$

$$\text{and } q'' = \frac{a\,q'}{c} = \frac{a\left(\frac{b\,c\,Q}{a\,b + a\,c + b\,c}\right)}{c} = \frac{a\,b\,Q}{a\,b + a\,c + b\,c}.$$

Thus suppose we have three Leyden jars, A, B, and C, whose thicknesses of glass are respectively 1, 2, and 3 units of length, and whose surfaces are respectively 9, 4, and 7 units of surface; then the inductive resistances of the three jars would be respectively as $\frac{1}{9}$, $\frac{2}{4}$, $\frac{3}{7}$,* or as 0·0111, 0·05, 0·043.

If we call a resistance of the same dielectric as the jars, and of 1,000 units of surface, and 1 unit of length, a unit of resistance, then the resistance of A will be 11·1, B=50, and C=43.

If now the jar A has a quantity equal to 100 units of quantity communicated to it, and the source then withdrawn, then if the interior of the jars B and C be brought into contact with the interior of A, whilst the outer coatings of the three jars are also in communication, the charge of A will redistribute itself, a portion passing into the jars B and C. And this total quantity will be redistributed in the inverse ratio to their inductive resistance.

The quantity in A will be—

$$\frac{50 \times 43 \times 100}{11{\cdot}1 \times 50 + 11{\cdot}1 \times 43 + 50 \times 43} = \frac{21500{\cdot}}{3182{\cdot}3} = 67{\cdot}5$$

In B—

$$\frac{11{\cdot}1 \times 43 \times 100}{11{\cdot}1 \times 50 + 11{\cdot}1 \times 43 + 50 \times 43} = \frac{47730{\cdot}}{3182{\cdot}3} = 14{\cdot}9$$

In C—

$$\frac{11{\cdot}1 \times 50 \times 100}{11{\cdot}1 \times 50 + 11{\cdot}1 \times 43 + 50 \times 43} = \frac{55500{\cdot}}{3128{\cdot}3} = 17{\cdot}4$$

† The sum of the three =99·8

By similar means the proportionate distribution of a given quantity on any number of surfaces can be determined, provided we can determine the inductive resistance which separates those surfaces from their opposing surface, no matter whether those resistances are shells, cylinders, or prisms of dielectric.

Thus it would be easy to calculate the distribution of a given

* It need scarcely be again repeated here that we are treating the resistances of the cylindrical portions of the jars as prisms, and that consequently the rule is only approximate within the limits of the ratio of thickness to radius in which the jars may be treated as prismatic resistances, as already pointed out.

† If carried out to more places of decimals the sum would approach more nearly to 100.

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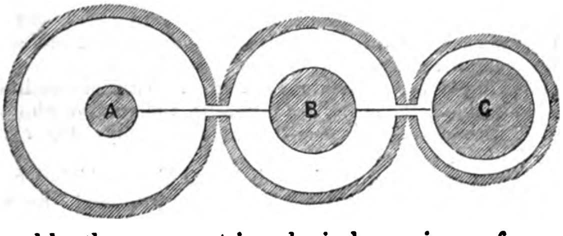
quantity on the four bodies A, B, C, and D (fig. 58), either in the case of their representing three spheres of different diameters,

Fig. 58.

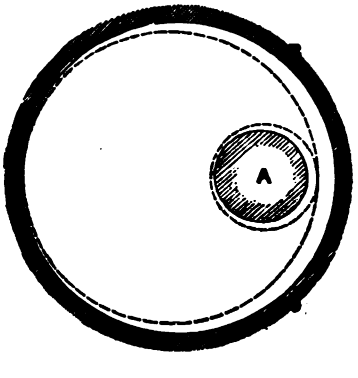


enveloped by three concentric spherical opposing surfaces of different sizes; or if they represent the sections of cylinders of different diameters having again lengths all different but given.

But where the inductive resistances separating each part of the one surface from the other surface can no longer be resolved into distinct and separate resistances, the calculation of the distribution can no longer be solved by the simple mode I have attempted to set forth.

Thus in the case of a sphere A (fig. 59) placed excentrically within a hollow spherical surface, B, C, D, it is impossible to

Fig. 59.



resolve the inductive resistances which separate the two surfaces in every direction into separate and distinct resistances; so that the distribution may come within the reach of the mode of calculation I have endeavoured to set forth. But although we cannot calculate the distribution in such cases by these means, still, it will be sufficiently evident in many cases at what points the inductive resistance between the two surfaces is at its maximum and minimum; and from this it will be easy to conceive something approaching to the general distribution that will take place, and which will be approximately represented in this case by the dotted lines.

In the case of some simple elongated figures, it can be easily demonstrated that the inductive resistance between the extremities and the outer surface (supposing that the two surfaces are separated by a stratum of dielectric of uniform depth) will be less than between any other part of the two surfaces, and consequently that the greatest accumulation will take place at those extremities.

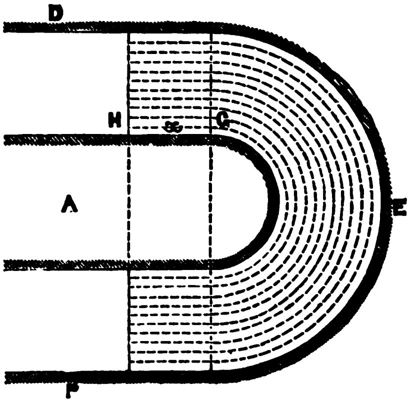
Thus, suppose A (fig. 60) to be a cylinder with hemispherical ends surrounded by an outer opposing surface D, E, F, of similar form and concentric with A.

Let G H be a portion of the cylinder, of such length that the surface of that portion shall equal the surface of the hemispherical end, and call this a unit of cylinder.

Then the resistance of an indefinitely thin layer of dielectric, x, immediately surrounding this unit of cylindrical surface, will be equal to the resistance of a layer of equal thickness on the hemispherical end.

Now the resistance of each successive layer around the unit of cylinder will be (as has been already pointed out) inversely as their radii, and the total inductive resistance, separating the unit of cylinder from its opposing surface, will be composed of the sum of the resistances of all these cylindrical layers.

Fig. 60.



In the same way the resistance of the successive hemispherical layers will be inversely as the *square of their radii*, and the resistance of the hemispherical shell is composed of the sum of the resistances of all these layers.

The resistance of each hemispherical layer decreases much more rapidly, therefore, than the cylindrical layers, and as the first cylindrical layer is *equal* to the first hemispherical layer, and there are the *same number* of layers in each case, it follows that the *sum of the resistances of the cylindrical layers must be greater than the sum of the resistances of the hemispherical layers.*

The resistance separating the hemispherical end from the outer surface is less, therefore, than between the two cylindrical surfaces, and the accumulation will therefore be greatest at the ends.

(*To be continued.*)

VISIT OF THE OFFICERS OF THE JAPANESE MISSION TO THE CENTRAL OFFICE OF THE ELECTRIC AND INTERNATIONAL TELEGRAPH COMPANY.

On the 19th inst., a few of the illustrious persons forming the Japanese mission to Europe paid a visit to the extensive establishment of the Electric and International Telegraph Company, in Telegraph Street, Moorgate Street. They were received by Mr. Fleetwood Varley, the Chief Electrician, and other officers of the Company. They were first shown over the Continental department, from whence Mr. Fischer sends his swift messengers to all parts by sea and land, and will, probably, in a short time, be able to communicate with his visitors when they shall have returned to their own city of Jeddo. The greatest attention was paid to the general working of the department, and Mr. Varley's explanation of the various ingenious apparatus employed, seemed to give great satisfaction, and full employment to the ready pen of the gentleman whom we presume to be the historian of the mission. Several messages were sent, and replies received fom various Continental towns, which called forth the most lively expressions of wonder and satisfaction.

They were next introduced into the "great room," where Mrs. Craig reigns supreme, "like Penelope among her damsels." The busy scene which presented itself appeared to afford them the greatest pleasure, and numerous enquiries were made as to the number of the young ladies employed, their hours of attendance, and their remuneration, as well as the general operations of telegraphy in this important department. There was among the visitors one officer whose demeanour appeared the very essence of reserved dignity. We failed to discover a single instance of a change of countenance. Nothing seemed to surprise or delight him, nor did the sly glances and the tittering of the young ladies seem in the least to affect his unimpressionable *sangfroid*. The pneumatic dispatch apparatus, conveying the printed messages between several of the Company's City establishments, was examined with a great deal of interest, and the

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continuous "popping out" of the "carriers" from their subterranean paths seemed to afford amusement, although our dignified friend moved not a muscle of his expressive countenance.

The beautiful steam machinery designed by Mr. Latimer Clark, for working the pneumatic apparatus was next examined, and Mr. Varley found ample employment in responding to the numerous enquiries addressed to him, the replies being carefully recorded. The operation of cutting the slips for the printing instruments was next examined, and explained by Mr. Grainger. One of the rolls of paper in the form of a disc, was presented to them as a memento of their visit.

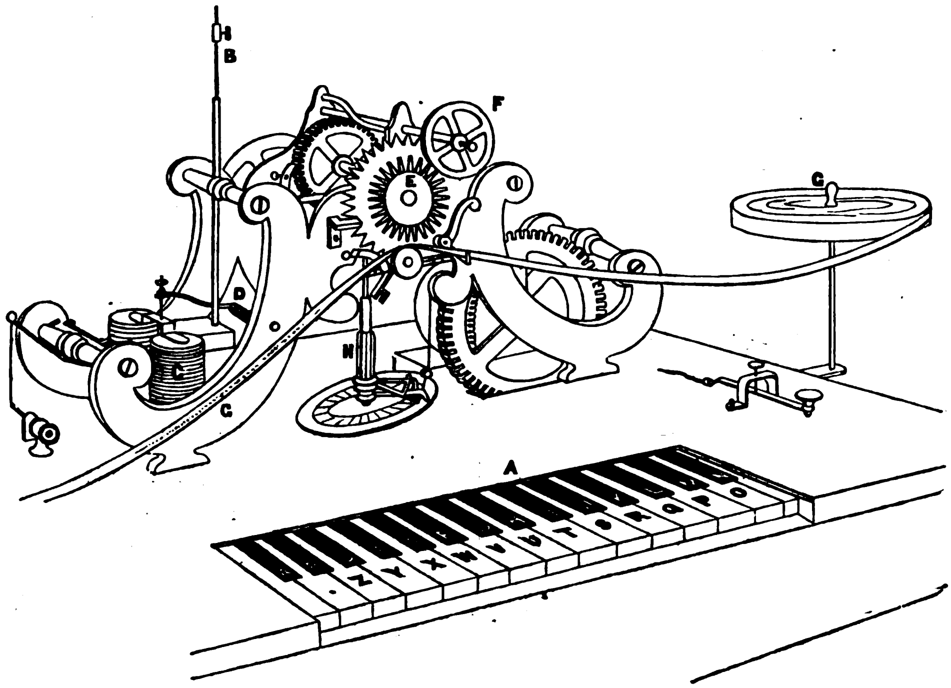
The battery cellars, described in page 158, were next visited, and the arrangements for distributing the power, &c., fully explained by Mr. Varley. One of the party volunteered to test upon his system the physiological effect of some 200 cells, and his example was speedily imitated, with the usual result of a greater or less degree of muscular contortion. We were curious to notice the behaviour of our unimpressionable acquaintance when forming part of the voltaic circuit. But, to our no small astonishment, his staid demeanour was preserved even under these difficult circumstances, and in his case the infliction of the shock was attended by none of the usual outward manifestions.

The distinguished visitors next proceeded to the Board Room, where they were shown various specimens of submarine cables which elecited numerous enquiries and explanations.

The following is the signature, in English characters, as inscribed in our note book, of the officer belonging to the mission who is best acquainted with our language:—"Fuesaw Ukitchy, Officer of the Japanese Mission."

The visit was pronounced to have been highly gratifying by those who, probably for the first time, had thus witnessed the various arrangements for electrical signalling, and the intention was expressed by them to introduce the same system into operation on their return to Japan.

PROFESSOR HUGHES' ELECTRIC TELEGRAPH APPARATUS FOR PRINTING IN ROMAN TYPE.



A Key Board; *B* Vibrating Spring; *C* Electro-Magnet; *D* Detent; *E* Type-Wheel; *F* Ink Roller; *G* Paper printed upon; *H* Revolving Shaft; *I* Revolving Arm or Circuit Closer.

THE following description of the Hughes' Printing Instrument is extracted from the paper of Mr. H. Hyde, read in May, 1859 before the Society of Arts, and will fully answer the inquiries which have been addressed to us relating to this arrangement. The Hughes' Instrument is already extensively adopted in America, and also to some extent on the Continent, though not in this country.

The Needle, the Morse, and the House instruments, as well as all minor ones hitherto worked with one wire, require an average of five or more electrical impulses or waves, or the time equal to this number, to transmit one letter. The recording in Roman type each letter of a message by a simple wave, upon one wire, is the triumph of the Hughes' system. To accomplish it, several requisites are necessary, which it may be proper to state, and then proceed to show how they are each obtained, and united in one harmonious whole, producing that life-like automaton present to demonstrate before you what is advanced, and practically to speak for itself in plain English. These requisites are, first, synchronous motion;* secondly, an electro-magnet, by which the timing of the electrical wave may be accurately measured; thirdly, a writing apparatus, by which the message may be correctly, rapidly, and easily transmitted; fourthly, a printing apparatus, by which the operator can record the message unerringly upon his own instrument, as well as upon the one at the distant station. Many inventors have attempted to make an instrument by which a letter could be sent by one wave, but without success. One reason was, that they had no governor of sufficient velocity and accuracy to produce synchronous motion. Professor Hughes provides a vibrating spring to govern his instrument. It is a well-known law that a certain number of vibrations produces a certain musical tone; therefore, if two or more springs have the same tone, they must necessarily have a certain number of vibrations in the same time. The instruments are kept in motion by a weight acting upon a train of wheels, the spring governor acting upon them by means of an ordinary escapement. These vibrations may succeed each other with any degree of rapidity required. They are regulated by a small weight attached to the spring, and raised or lowered until the number of vibrations, or the desired tone, is produced. This can be done easily and quickly, although the instruments may be any number of miles apart, as in London and Paris, or in Ireland and America. The type wheels of the instruments revolve at the rate of one hundred and twenty revolutions per minute, and the governor makes fifty-six vibrations for each revolution of the wheel.

* Synchronous—keeping the same time. Synchronism—motion at the same rate.

The Magnet.

The Hughes' magnet is of peculiar construction. A permanent magnet polarizes the cores of an electro-magnet, and holds an arma-

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ture in contact with its poles. A spring is attached to this armature, and so adjusted as to exert a counteracting power a little weaker than the force of the magnetic attraction. If, therefore, the magnetic force be diminished, the armature is removed from the poles of the magnet by the force of the spring. The arrangement is such that the current of electricity passing through the coil when the circuit is completed, induces an opposite magnetism to that of the permanent magnet. The electrical force, therefore, which works this instrument need not be sufficient to induce such a degree of magnetism as to render the core sufficiently magnetic to attract an armature to its poles—the practice in all other recording telegraphs. For instance, if the cores of the electro-magnet, have a holding force upon the armature of ten, and the spring attached to the armature be adjusted with an opposing force of nine, then a current of one reducing the force of the electro-magnet would cause the spring to rise with the force of nine. This arrangement can in practice be so nicely adjusted as to work with a very feeble current, and accurately measure the timing of the electrical wave. The armature being mechanically restored to contact with the poles, has the advantage of being acted upon by the maximum power of the electro-magnet, instead of a power lessened by more than the square of the distance the armature has to be attracted, as is the case in the relay magnets used in connection with the Morse and other systems.

Transmitting Apparatus.

The letters of the alphabet, as well as a dot and a blank, are marked on twenty-eight keys, arranged like those of a piano, save that they are alternately black and white. These keys correspond to twenty-eight holes arranged in a circle on the horizontal floor or table of the instrument, immediately in front of the keys. Each key is connected by a lever with a little steel knob, which, when the key is pressed down by the finger, rises up through one of the holes. An arm, connected with a vertical shaft, sweeps over the twenty-eight holes. If a key marked with a particular letter be touched, the knob corresponding with this letter rises, the revolving arm passes over it, and for the instant closes the circuit, and allows an electrical impulse to be transmitted. This impulse, by arrangements which will be described in the printing apparatus, causes the particular letter to be recorded on a slip of paper in printer's ink. The instant the arm passes over the little raised knob, the circuit is broken, and if the finger were held a hundredth part of a minute on the key, the hand would pass again over the knob, and the letter would be repeated. To prevent this, the hand carries, after the portion of it which rides over the knob and completes the metallic contact which closes the electrical circuit, a little inclined plane, which throws the knob out of its position, so that the hand cannot pass over it on any future occasion after the first contact. This arrangement is rendered necessary to prevent the repetition of letters, on account of the extreme rapidity of the revolving arm and recording apparatus.

Printing Apparatus.

A shaft, which revolves seven times faster than the type-wheel, has a fly-wheel upon it, to overcome the inertia of a small shaft, which moves the printing press. This shaft is locked to the fly-wheel shaft by means of a clutch, which rests upon a small inclined plane. Whenever this clutch is kept upon the inclined plane, by means of a detent, the fly-wheel shaft revolves independently of the small printing shaft; but as soon as the detent is moved by the action of the armature of the electro-magnet, the clutch locks both shafts together, and the small shaft is made to revolve one revolution, when the clutch again rests upon the inclined plane, which lifts it off the fly-wheel shaft. A cam is attached to one end of this shaft, which lifts the press, and the paper on which the message is to be printed, against the type-wheel. The time of the locking of the shafts depends upon the arrival of the electrical wave, and thus, with two instruments in perfect harmony, the operator has the printing apparatus of the distant instrument as completely under his control as the one before him. But, to correct any minute variation in time between the instruments in circuit, there is a corrector wheel attached to this shaft, with hook-shaped teeth, which work into corresponding cavities in the type-wheel. The latter being loose upon the shaft, or only held by friction, is removed backwards or forwards by the connector to exactly the same position as the type-wheel on the instrument from which the message is being sent. This correction takes place in the act of printing every letter. There is also upon this shaft a cam, so arranged that the moment the armature falls off the electro-magnet and opens the detent, it forces the detent up, and restores the armature to its original position upon the poles of the magnet.

Another new feature in this instrument is its power of cutting off at will all offices except the one to which it is desired to communicate. This is accomplished by a flange on the type-wheel—this flange having a space cut out apposite a certain letter, and each office having the flange cut out at different letters from each other. A bolt is made to slide through the space, and moved through by the action of the instrument. If this bolt is sent through at the moment the space is opposite, it permits the instrument to run, if not, it goes against the flange and locks the type wheel. The operator, knowing at what letter a certain instrument will be unlocked, touches that key. This allows the instrument he wishes to communicate with to run; and he can send the message to that one, the other offices being unable to get it, as they would be locked, and could not bring their instruments into unison with the one sending the despatch. Thus, it is absolutely secret in its transmission, and, if necessary, anyone could send his own message, as it is only necessary, to insure its safe arrival, to touch the right keys, which are all lettered.

The electrical circuits are extremely simple. The earth-wire connects with the steel pins or knobs on the keys of the transmitting apparatus, and from the revolving arm through the electro-magnet, and thence through the line and distant magnet to the earth. Reversed currents are not necessary except on long submarine wires. There may be as many instruments in circuit as may be desired. The *European News*, consisting of about 3,000 words, by the arrival of each Trans-atlantic steamer, is transmitted by this instrument from Boston to New York, a circuit of about 300 miles, at the rate of 2,000 to 2,500 unabbreviated words an hour. There are 25 stations on the circuit which recieve copies or the news, all of which are printed in plain Roman type by the Boston operator, all the instruments receiving the message at the same time, the receiving clerks at each station having simply to hand the copy as it arrives, to the party entitled to receive it.

The mode of operating with this instrument is extremely simple, and easily acquired. The office desiring to transmit a message, calls the station by touching the keys in a pre-arranged order, the distant office at once returns the signal "O. K.," or all right. The manipulator then commences the message, first striking the zero key to start the distant type-wheel in unison with his own. If the message is received correctly he is allowed to finish, and then the operator at the distant office gives the return signal of all right; if there is a mistake the receiving office touches his key board which throws extra letters to the transmitting station, and he then commences again from the point where he made a mistake. There can be no mistake, however, if the operator touches the right key, and manipulators become so expert that they seldom touch the wrong one; if they do, the error is shown by the copy of the message on their own instrument, and immediately corrected.

If I have succeeded in conveying a clear and intelligible impression of the principle of the Hughes' system, it may be proper to invite your attention to what appear to me to be natural deductions. *Accuracy* is secured by unerring mechanical laws, and not by the skill of the operator, as in the needle or Morse systems. Not only this, but in all other systems, if one of the symbols be missing, another letter is formed by the remaining symbols. *Rapidity* is secured by reducing the labour to its minimum. A single touch of a key prints the letter, instead of three or four vibrations of a needle or a similar number of motions of a key, as in the formation of symbols to represent letters. Accuracy and rapidity being thus secured, ease and simplicity of of manipulation must of necessity follow, and consequently the young operator readily acquires his or her education. The nstrument, however, is specially adapted to females. The one wave system is specially important on long submarine circuits, where electrical impulses are limited, one wave being sufficient for a letter instead of five. Great difficulty has been experienced on long cables by the variation of time in the transit of the wave. By this correct timing instrument, simple and perfect compensation is mechanically attained for any length of wire or extent of variation. The sensitiveness of the magnet also enables this instrument to record more waves upon a long circuit than any I have yet met with. The rapidity of an instrument, however, does not consist only in the fact of its extreme sensitiveness, but also in its power to free itself from the influence of a current so soon as the effect of the current has caused the instrument to record the signal or letter sent. This property, attained by the electrical and mechanical combination of scientific laws, embodied in the design and construction of the instrument, and demonstrated by the results produced, must in time remove all doubt of its superiority, while its English tongue, represented in plain printed Roman characters, will tend to make it the favourite of the Anglo-Saxon race.

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THE NAIL IN THE CABLE.

MURDER is not the only crime that refuses to be concealed. It seems to be part of the Divine arrangement that in proportion to the sanctity of an object it is protected from violation, by diminishing the chances of impunity attending the act of violation. When it was first proposed to make use of the ocean as a channel of telegraphic communication, and to lay down in the bottom of the sea a wire which is sentient as the thread that warns the spider of his approaching prey, the question was asked, what will become of the cable in time of war? And it was argued that, even in the midst of hostilities, the sacred link would be venerated, like the territory of ancient Olympia. Even in war, for an enemy to injure the continuity of a submarine telegraph would be looked upon as an act belonging to the same class of barbarities as the poisoning of an aqueduct, the bombardment of a church, the burning of a public library. But that which the red hand of war would have shrunk from has been perpetrated by the hand of commerce; and an act too bad for Moloch has not been too bad for Mammon. The extraordinary revelations brought out in the case of "Glass *versus* Boswall," recently tried by a judge so acute as Lord Chief Justice Erle, are calculated to give such a shock to the mind as could scarce, we believe, be exceeded, were the shell of the globe suddenly to crack at one's foot, disclosing the central abyss and the surges of the sea of fire. Such a fissure has in fact been opened in the shell of external respectability, and we ask the reader to look into it. Even an object of horror has its attraction, and lays the beholder under such fascination that he cannot choose but gaze—even though he shudders as he gazes. No adequate report of the case appeared in the London papers, but the notes of the shorthand writer have been published, and not only the evidence taken at the first trial, but the argument when a second was applied for, is now in the hands of the public, in two Blue Books, extending to about two hundred pages each. We do not require to mention here—the thing having occurred so recently—the sensation produced in the public mind by the announcement that the telegraphic cable, which the firm of Messrs. Glass and Elliot were employed, in 1858, to lay down between Dunwich and Zandvoort in Holland, 140 miles in length — and which, in one of its wires, suddenly become inoperative one night, with about seventy miles of it in the water, some time between five minutes before and five minutes after nine—was found to have had a nail driven through it, to destroy the isolation of the wire. Stories have been told of skulls turned out of a grave by the sexton, with a rusty nail in the bone, accounting for the dead man's sudden death in a way that had never been suspected. It was so in the present case. On the evening of the 22nd of September, halfway between England and Holland, at the hour above mentioned, the application of an electric test showed that one of the wires in the rope had been paralysed; and the test indicated, moreover, that the agent of destruction was metallic. The vessel, which was the *William Cory*, proceeded to England, landing the cable at Dunwich; and it was not until some time after, when vessels were despatched for the purpose, that a portion of the cable where the fault had occurred was fished up and sent back for examination, for the mode of testing is so perfect as to enable the searchers to say that, whatever the fault might be, it would be found at some particular point, in a portion two or three feet long. The iron strands with which the rope is covered externally were removed, and lo! as in the case of the skull, a nail was discovered in the texture, which had been treacherously driven in till it reached the brain-matter of the telegraph! The question was now that which occurred to the sexton, Who committed this murder? How came that nail there? Not without hands certainly, not without malice certainly, certainly not without design. The immediate hand, it was obvious, had been employed in the vessel. But as the Solicitor-General for Scotland, who conducted the prosecution of the surgeon Smith, in the case of the St. Fergus murder, remarked of the peculiar bloodlessness of the wound, owing to the part of the head at which the pistol had been pointed, that that wound had been made by a skilful—in fact, by a surgical—hand, so we might aver here that the outrage was the work of science. An ordinary unlettered workman would scarce have alighted on the discovery that so much mischief might be done by merely driving a nail in. No one on board the vessel, moreover, could have had any interest in putting his employer to the expense of seven or eight thousand pounds. An enemy had to be sought for, one with some interest in the mischief, and with some disposition to do it, who would probably act in the way that Troy and Babylon were taken by getting a man into the fort for the simple purpose of betraying it. They began to look out for the likeliest person to have played the part of Sinon. Violence is the punishment of violence, and treachery succumbs to treachery. The malignant plot was betrayed, and an anonymous letter directed Mr. Glass to the guilty party. The establishment at which the cable was made at East Greenwhich is separated by only the breadth of the river from the rival establishment at Blackwall, that of the Messrs. Newall, whose manager in the Strand, is Mr. Boswall, the defendant, at least the nominal defendant, in the action we are considering. These two establishments may be regarded, we presume, as the sole manufactories of submarine cable in England. Without going into details, then irrelevant to the point at issue, suffice it to say that the proverb about "two of a trade" found no exception to its accuracy in these two rival establishments. They had already been at law, and, but for the foulness of the act, the presumption was that the actor must have belonged to the opposite house. Whatever the presumption was, however, the aggrieved firm seem to have acted with a prudence that is very admirable: instead of throwing a doubt on whatever evidence might be forthcoming, by offering a reward for the discovery, they allowed the secret to lie and fester, confident that a bad secret would mature its purulence in time, and force itself out at last. In the month of June, 1859, a man of the name of Curtis caused a letter to be written to Mr. Glass, intimating that one of his workmen was a spy in the pay of the Newalls, information which, upon inquiry, proved to be perfectly accurate. Mr. Glass, on a subsequent occasion, had an interview with Curtis, his informant, and then discovered that Curtis himself had played a similar part. He had sailed with the vessel that laid down the Dutch cable, and had received his full wages from Newall's to get himself introduced into the service of the rival company. As regularly as Saturday night came round, he had thirty-three shillings paid him at Newall's, while engaged with Messrs. Glass and Elliot. No man can doubt that he was there for a wicked and treacherous purpose. An ill secret is ill to keep, and in due time he avowed the fact that he had been employed by Mr. Boswall, Mr. Newall's manager, to engage himself with the *William Cory*, and destroy the cable laid down, which he was actually shown how to do, by driving a tenpenny nail in. Hence the action of "Glass *versus* Boswall." And in our estimate of the transaction, we agree with the defendant's counsel, that the question which the jury had to decide was whether or not he had been "guilty of perjury, and the basest and most wicked act that one man can commit towards another." They decided it in the affirmative, and they had really no alternative. Curtis himself described the act in terms as forcible as just, when he declared that it was like running a knife into a man's back. With that nail Boswall has nailed himself to infamy, if not to ruin. But when we think we are at the lowest depth there is sometimes a deeper still. We have not finished our story. It seemed some consolation, in dealing with so sickening a system of treachery, subornation, and espionage, that we were at least able to say, "Mr. Newall knew nothing of this." Honourable men do not fight the battles of competition in this way. An honourable man would as soon have a spy in another man's family as a spy in another man's workshop. We were gratified, therefore, to find Mr. Boswall pointedly swearing that Mr. Newall, though he knew in October that some information had been got from a man in the employment of Glass and Elliott, had not the remotest idea that the man had been sent out by the Newall establishment, and was receiving the Newall pay. *That* he never found out, he said, till October, 1859, more than a year afterwards. And Mr. Newall, in his turn, made oath to the same effect. He was asked, by his own side, when he first heard of Curtis having been paid to go and report; to which his reply was, some time after July in 1859. This was so agreeable a thought that we wish he had left us to indulge it. But the fatuity attendant upon evil courses seems to have pursued them all, for nothing would serve, when the verdict went against them, for they must move for a new trial. In support of that motion affidavits were filed, of course; and these happened, unfortunately for the writers, to involve the production of the letters that had passed between Boswall and Newall, and one of their warehouseman called Stevens. So late as in November, 1860, both of the two former made affidavits to the effect we have mentioned, that Mr. Newall knew nothing, until a long time afterwards, of Boswall's employing spies, or suborning and corrupting the servants of rival house.

> "Talibus insidiis perjurique arte Sononis
> Credita res."

Judge of our surprise, after so many oaths, then, on finding from Mr. Newall's correspondence that he had not only known of, but positively suggested, the practice both before and at the time of his rivals' laying down the cable to Holland. The voyage of the *William Cory* commenced on the 18th of September, Curtis sailing with the rest. We take the following extracts from the letters. On the 2nd of September, 1858, Stevens writes to Newall, "Glass and Elliot commenced yesterday paying-in the rope on board the *William Cory*. *I sent a man* on board yesterday; he was there an hour. I shall send him again in a day or two report." Four days afterwards (6th Sept., 1858), Newall, writing to the firm, 130, Strand, expresses himself as follows:—"I am annoyed I cannot get any information as to what sort of coil Glass and Elliot are making of the Holland cable. Phillips writes the man I sent could see no cone; but he does not say what he did see." The cone referred to here, let us explain, was Newall's patented contrivance for preventing a rope from kinking while in the act of paying it out. Messrs. Glass and Elliot, however, obtained the same result by peculiarly simple contrivance. Two days later (8th September, 1858), Boswall writes to Newall and Co., "In reply to Mr. Newall's letter we have to state that one of our men has again been aboard the *William Cory*. This man, and others, have hitherto got on board under pretence of offering their services as sailors, or to assist in paying-out, and there is a probability that Craigie may be taken on." This Craigie, we believe, is a foreman rigger with Newall. Well, next day (9th September, 1858), Mr. Newall refers to Craigie in a letter to the firm, 130, Strand, where he says, "I hope Craigie may be employed, and tell us what is done." On the 18th, it will be remembered, the *William Cory* sailed with the spy Curtis on board, of whom Mr. Newall swore in the witness-box he had never heard until after July, 1859, Boswall stating that it was actually in October. And yet we have Curtis referred to here in a letter from Boswall to Newall, of date Sep-

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ember 25th, 1858,—"The *Cory* is returned. They have offered to take the same man, and I have recommended him to go." To this Mr. Newall replies in a letter to the firm, 130, Strand, of date 28th September, 1858. "Let the man see Mr. Liddell, but don't tell anyone that we sent a man on board. There can be no objection to saying that we got the information from a person who was on board." In a subsequent letter from Boswall (September 29), the man's name is given as Curtis. These are startling disclosures. What is this kind of swearing called? Move for a new trial, gentlemen! The only wonder is that there has not already been one, on the side of the Court that takes cognizance of suits that are not civil. Did you never hear of the man who lifted a stone to crush his neighbour, and let it fall on himself? Do they not feel that accursed nail running into their souls at this moment?—*Northern Daily Express.*

A NEW PROJECTILE FORCE.

BY THOMAS M. MESCHIN, D.C.L., F.S.A., OF THE INNER TEMPLE, BARRISTER.

WATER may be decomposed into its constituent elements, oxygen and hydrogen gases, either by voltaic electricity, by common electricity, by magneto-electricity, or by thermo-electricity.

1. *By Voltaic Electricity.*—When the electrodes of a voltaic battery are brought near to each other, in acidulated water, or, in other words, when water is made part of a galvanic circuit, so that the current of electricity passes through it, decomposition ensues—its constituent elements, oxygen and hydrogen gas, are evolved at the electrodes.

2. *By Frictional Electricity.*—Water may also be decomposed by passing a succession of discharges of common electricity through it. This was accomplished so early as 1789, by Messrs. Dieman Paetz and Von Troostwych. Professor Faraday and Mr. Goodman have also succeeded in obtaining true electro-polar decomposition of water by the action of frictional electricity.

3. *By Magneto-Electricity.*—Water can also be decomposed by a magneto-electric apparatus, for, if it be made part of the circuit, as often as the circuit is completed, a current of electricity passes through the water, and the gases are thereby evolved.

4. *Thermo Electricity.*—Water is very easily decomposed by a thermo-electric pile, the electrolysing action of which is maintained by keeping the ends of the bars of which the pile is composed, the one at a high and the other at a low temperature.

The different forms of electricity known under the above names, may be used either separately or simultaneously for the decomposition of the water in the gas generator.

When this evolution of the gases takes place in a close vessel, or gas generator, a gradually augmenting compression necessarily results, which does not affect the evolution of the gases in the slightest degree. An exceedingly high pressure may thus be obtained in the gas generator or close vessel. Dr. Daniel raised it to the enormous tension of 56 atmospheres, or 840 lbs. on the square inch.

In the "Philosophical Transactions of the Royal Society, 1839," vol. 129, p. 93, 94, Professor Daniel thus describes an experiment:—"The evolution of gas, which was measured at short intervals, took place with perfect regularity, and did not appear to be in the slightest degree affected by the gradually increasing compression. In four-and-a-half minutes, when 19 cubic inches had been collected, the compression tube burst with a loud explosion, and the fragments, which were very small, were scattered all over the laboratory. If we were to calculate that 19 cubic inches were compressed into three-tenths of an inch space unoccupied by the liquid, this would be a compression of 63 into 1, and the pressure would amount to nearly 940 lbs. on the square inch; but if we reckon, as was probably the case, that two cubic inches of the gases were kept down by the solvent power of the liquid at this high pressure, then the compression would have amounted to 56 into 1, and the pressure to 840 lbs. on the square inch."

ELECTRIC GAS GUN.

The gases evolved at a high pressure from the decomposition of water, by electricity, constitute a projectile force of very great intensity. By using them in the same way that air is employed in an air-gun, the greatest conceivable force may be impressed upon a projectile, a force, apparently, only limited by the strength of the materials of which the gas-generator is composed. Gunpowder is itself only a highly inflammable mixture, which, on being ignited, is rapidly converted into gases at a high pressure, and the gases in the electric gas gun would act upon the projectile in precisely the same way as the gas resulting from the ignition of gunpowder acts upon a similar projectile in an ordinary cannon; thus the force of gunpowder and that of these gases are analogous.

As to the form of an electric gas gun, it is similar to a breech-loading gun or cannon. Attached to the breech is a reservoir, or gas generator, in which water is converted into the gases at such high pressure as the officer in command may deem requisite. There is a communication between the gas-generator and the barrel or chase of the weapon, which can be opened or closed at pleasure, but which, if not closed before, will close of its own accord when the full charge of the weapon has passed into the barrel. This is accomplished either by a slightly conical piston or spigot, acting in a small hole, through the barrel of the weapon, so placed that when a shot has passed over the point where it is situated, the gases press upon this piston or spigot (which is kept down by a spring), and raising it by their pressure, it acts by suitable mechanical contrivance upon the apparatus for closing the communication; or by making the shot, when it passes over a certain point in the bore, complete and break an electric circuit, which acts by suitable machinery upon the apparatus for closing the communication.

An apparatus for closing this communication is so constructed, that when it is completely closed, and not by any possibility till then, several electric sparks are passed through the gasses in the barrel, which result in their explosion, and the discharge of their weapon, for I should have mentioned that these gases are endowed with a second element of force—they may be combined with an electric or other spark; or the gases may be exploded as gunpowder by the percussion of ordinary detonating powder. In combining they expand to fifteen times their volume. When the shot has, by passing from the breech to the muzzle, attained the uniformly accelerated velocity due to the high pressure of the gases, and is on the point of leaving the weapon, if the gases be then exploded the explosion will impress a force upon the shot equal to fifteen times the pressure of the gases. The small portion of pure water, which is formed by the combination of the gases, is condensed like dew on every part of the bore, and serves to lubricate the weapon, or, according to the temperature of the barrel, remains in the form of vapour, and is driven out by the succeeding discharge—the barrel never needs cleaning.

At the breech there is an aperture through which the shot is introduced into the barrel with great rapadity after each discharge, by means of a very simple piece of mechanism. The aperture has its edges bevelled outwards to insure the fitting of the piece that fills it up when the shot is introduced; there are several of these pieces accurately fitting this apperture, connected with each other by suitable links, and forming an endless chain. When the weapon is in the act of being discharged, there is a strong band, nearly half the circumference of the outside barrel, which is so fastened by adequate mechanical contrivances, that on the recoil of a gun after the discharge, the band is loosened by the action of the recoil, and the piece occupying the aperture falls out, and another piece bearing a shot, is brought by the action of the recoil of the weapon upon an incline, under the aperture, which piece, by the return action of the weapon down the incline, is, with the shot upon it, forced into the barrel, and the band again fastened by the same return action. The shot is delivered from a hopper or reservoir of shot (or may be placed by the hand) upon one of the pieces, by means of, and during the upward action, of the recoil. Instead of the band, or in conjunction with it, a strong bar may be used, attached by a sort of hinge to the weapon, near the muzzle, and so arranged that when the weapon is being discharged, the end of the bar presses, with the whole weight of the weapon, against the piece occupying the aperture so as to resist the force of the gases, and when the weapon recoils, the pressure of the bar against the piece ceases and suffers it to fall out, and the next shot is introduced in the manner before described, whereupon the bar is made, by suitable mechanical contrivances, to resume its pressure against the piece by the return action of the recoil.

It is intended that the weapon shall be loaded, aimed, discharged, and entirely worked by machinery, and that the weapon and its whole working shall be capable of being fought, and in every way controlled, by a single man.

The force thus developed would seem to be the best possible force to which a projectile could be subjected—a uniformly accelerated force while moving along a rifled barrel, and then (when it was received from the rifled bore a motion round its own axis) an almost instantaneous accession of immense force. It is quite obvious that these conditions are much more favourable for allowing the length of the bore or barrel of the weapon to be increased, and thereby securing greater precision of aim, and are also more favourable for the preservation of the weapon, than when the projectile is, as in the case of gunpowder, subjected to a constantly increasing and then to a constantly diminishing force. It is not, perhaps, too much to say, that a rifled electric gas gun would wear as long as a couple of rifled cannons in which gunpowder was used.

Sir H. Douglas says p. 47):—"The main principle which should govern our choice of naval guns is, to prefer those which, with equal calibre, possess the greatest point blank range; and the practical maxim for using them should be to close to, or within that range, and depend upon precision and rapidity of fire. This is the most simple and the most efficacious use of artillery."

An electric gas gun, if wrought by machinery, would have the greatest possible precision, and its rapidity of fire might rival that of a revolver; and it is perfectly obvious that it might be lengthened to any extent, so as to secure the greatest attainable point blank range.

"It is known, both from theory and practice," says Sir Howard Douglas (p. 96), "that with equal charges and guns of equal weight, but of different lengths, the velocity of the shot increases with the length of the bore." Now, these gases are much more capable of being used in weapons with great length of bore than gunpowder, because the shot is driven from the breech to the muzzle, not, as in gunpowder, by a constantly increasing, and then a constantly diminishing force, but by a uniform, or nearly uniform force, which is perfectly under command, and then is subjected to an explosive force; these are the very properties in a projectile force most favourable to precision, and the greatest point blank range. From practice at Deal, in 1839, with 32-pounder guns, one 9 ft. 6 in., and the other 6 ft.

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6 in. long, with charges of 6 lbs., and windage of ·175, the elevation being one degree, the range of the longer was 853 yards, while that of the shorter one was only 734 yards.

These experiments show the very important effects resulting from a lengthened bore, but, owing to the nature of gunpowder, the limit to the length that can be used in practice is soon reached; but the case, as respects the gases, is wholly different; there is nothing whatever to prevent that length being adopted, in the electro-gas gun, which will secure the maximum result.

These gases have another great and pre-eminent advantage over gunpowder, viz., that the force impressed upon the projectile may be varied according to the work itended to be done by it. If a *ricochet* is required, only a small quantity of gas may be admitted into the barrel of the weapon; no time need be wasted in altering the charge, the officer in command may increase or diminish the intensity of every succeeding shot without the slightest difficulty or delay. This would be in the highest degree useful, as well as economical, in finding and altering ranges—useful when a tentative process was desirable; economical, because the angle of elevation which gave the maximum result of the minimum expenditure of gas might be given to the weapon, and the charge varied with the required range.

From the experiments of Robins and others, it apears that when gunpowder is ignited, one-half of it is converted into gases (the principal of which are carbonic acid and azote) and the remaining half assumes the form of solid matter. If the powder be loose, the volumes of the gases are from 236 to 260 times that of the powder; in rammed powder from 480 to 520 times the volume of the powder. As to the expansion of the gases due to the elevated temperature at which they are generated by the ignition of the powder, the estimates are widely dissimilar. Robins set down the absolute explosive force of gunpowder equal to 1,000 atmospheres, that is, a pressure of 14,722 lbs. on the square inch; Hutton put it at 2,200 atmospheres, or 32,388 lbs. on the square inch. It is obvious that a considerable portion of the heat is absorbed by the gun.

With respect to the air-gun, the "Encyclopædia Metropolitana" remarks, adopting the estimate of Robins, "if the air-gun be condensed ten times, the velocity will be equal to one-tenth of that arising from gunpowder; if condensed twenty times, the velocity would be one-seventh that of gunpowder, and so on. Air-guns, however, project their balls with a much greater velocity than that assigned above, and for this reason, that as the reservoir of condensed air is commonly very large in proportion to the tube which contains the ball, its density is very little altered by passing through that tube, and consequently, the ball is urged all the way by nearly the same force as at the first instant; whereas, the volume of the gas arising from inflamed gunpowder is very small in proportion to the barrel of the gun, and by dilating into a comparatively large space as it urges the ball along the barrel or tube, is proportionately weakened, and it always acts less and less upon the ball in the tube. Hence it happens that air compressed only ten times into a large receiver will project its ball with a velocity little inferior to gunpowder."

What is here said of air applies with equal force to the gases. Besides, the ignition of the charge of gunpowder is not instantaneous; it is a progressive operation, so that the ball when projected by gunpowder is subject, when passing from the breech to the muzzle, first to a constantly increasing, and then to a constantly diminishing force.

It will be interesting to contrast the cost of gunpowder and of the gases. The length of a 68-pounder is 9·49 feet; the effective length is less by the semi-diameter of the bore, which is 8·12 inches, the length is, therefore, 9·11 feet, and the capacity 4·41 cubic feet. As a ton of zinc evolves 1,966 cubic feet of the gases under a pressure of ten atmospheres, and as its price varies from £20 to £30, the cost per round of shot, out of a 68-pounder, would be as follows, under the following pressure. At—

10	atmospheres	0s.	9d.	at £20 —	1s.	4d.	at £30.
20	"	1	9	" —	2	8	"
40	"	3	7	" —	5	4	"
60	"	5	4	" —	8	0	"
80	"	7	2	" —	10	9	"
100	"	8	2	" —	13	5	"

Now, if the "Encyclopædia Metropolitana" be correct in saying that air, compressed ten times, will project a ball with a velocity little inferior to gunpowder, surely these gases, when compressed ten times, that is, to a pressure of ten atmospheres, and exploded, ought to rival or surpass gunpowder, as they would, in addition to the force due to the ten atmospheres, impress a force on the projectile, at the moment of its flight, fifteen times that pressure. But when contrasting the cost of the gases as a projectile force, and that of gunpowder, it is safer to be under, rather than over the mark, so then, notwithstanding the *dictum* of the "Encyclopædia Metropolitana," we will base our calculation on the assumption that the gases condensed 20 times, and developing on their explosion a force equal to 300 atmospheres, will produce effects equal to those of gunpowder; the cost for shot will, as we have just seen, be from 1s. 9d. to 2s. 8d.*

The cost of gunpowder varies, of course, with the price of the articles from which it is manufactured; it ranges from one to two shillings per lb. A 68-pounder takes 16 pounds for a charge; the cost per shot is, therefore, from 16s. to 32s., consequently the gases are by far the cheaper force, for even at 100 atmospheres they would only cost from 8s. 2d. to 13s. 5d., scarcely one-half the price of gunpowder, but at 20 atmospheres they would scarcely be one-tenth of the price.

Gunpowder is deteriorated or destroyed by the absorption of moisture; this could not happen to the gases. This absorption of damp is a constant cause of "great and unknown losses of strength," and a little more or less moisture will alter most materially the accuracy of practice. Attempts to protect gunpowder from moisture are a constant source of heavy outlay, which should be borne in mind when comparing the relative cheapness of the forces, and "no degree of care" can altogether preserve it from receiving some injury. (Sir H. Douglas.)

Then the force impressed upon the projectile might be increased *ad libitum*. This cannot be done with gunpowder, for if the charge be increased beyond a certain point, a diminution of force results, as part of the powder is shot away unignited, and the powder ignited acts for a shorter space on the ball, but in the electric gas gun the pressure may be raised to any point in the gas generator, so as to impress the required force upon the projectile; thus, if it was found that a 100-pounder, propelled by a force equal to that of gunpowder, had no effect upon an iron-plated vessel, the force might be doubled or trebled until the desired result was achieved; indeed, it is probable that these weapons would settle the question of armour-plates, because if, as Mr. Scott Russell holds, the thickness of the plates cannot be usefully increased beyond 4½ inches, as soon as a weapon is constructed of sufficient force to destroy this armour, it will cease to be a protection, and will only insure the sinking of capsizing of the unlucky vessel it was intended to protect, like the knights of former days, whose armour at last became so heavy that, if they chanced to be unhorsed, they were compelled to lie prone, unable either to renew the fight, or to consult their safety by a retreat.

It may be observed that it would be difficult, when the firing proceeded from works in any way extensive, or from masked batteries, for an enemy to discover the precise point where one of these weapons which threw the projectiles was situated, as there would be no smoke and no report (for a vacuum would be formed by the explosion of the gases). In most cases this would prove of signal advantage, among others—as not affording a mark for the shot of the enemy, should he seek to disable the weapon. Besides, the absence of smoke would not interfere with the aim of other weapons, and the absence of noise would enable the orders given by those in command to be distinctly heard.

There would be practically no report; the report, such as it would be could not be heard beyond a few yards—it would be 500 times less than that of a cannon, and 10 times less than that of an air-gun.

When a cannon becomes heated by repeated discharges of gunpowder, the elasticity of the metal of which it is composed is diminished, and the properties of the weapon are impaired. It is probable that rifled cannon (other things being equal) are liable to be more quickly heated than those with a smooth bore, owing to the fact that the ball meets with greater resistance in moving along a rifled bore than a smooth bore, and, consequently, consumes more time in reaching the muzzle. The barrel of the weapon is, therefore, subjected for a longer period to the action of the highly heated gases evolved by the ignition of the gunpowder. This result could not arise from the action of the gases in the electric gas gun, for the heat evolved by the detonation of the gas is by no means great. The electric gas gun is, therefore, so far as this point is concerned, the more perfect weapon, being capable of more incessant and prolonged work.

(To be continued.)

International Exhibition.

In a previous number we inserted a list of telegraphic instruments now exhibited at the Industrial Palace at Kensington. We now publish a list of the various insulating materials, submarine cables, &c., which are to be found in various parts of the building. In the Eastern Annexe, devoted mostly to the exhibition of vegetable produce, will be found the display of gutta percha in its various progresses of manufacture. The first display which arrests our attention is the very interesting case of the Gutta Percha Company, Wharf Road, City Road. The company exhibit the gum in its various stages of manufacture, and its innumerable applications. Specimens of Submarine Cores, Insulating Stools, Battery Cells, Handles for Discharging Rods, Electrotype Moulds, and Galvanic Batteries, are exhibited. The texture, transparency, and cleanliness of the thin sheets displayed, prove that vast improvement has recently been effected in the manufacture.

We next find ourselves in the presence of the venerable father of the gutta percha trade, Mr. Charles Hancock, whose likeness, we are informed, is to "the life." The West Ham Gutta Percha Company also exhibits several specimens of submarine cores and electrical apparatus, evidently of an improved description. Mr. James Lyne Hancock contributes specimens of vulcanized india rubber tubing, washers, &c. The Southwark India Rubber Company a collection of combs, knife handles, smoking pipes, walking sticks, &c. Mr. Peter Cow, of Cheapside, various articles in vulcanized rubber. Messrs. Charles Macintosh and Co. the application of india rubber to almost every conceivable pur-

* See Appendix I., p. 414.

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pose, from a child's toy to a life boat. Messrs. Warne and Co., india rubber goods of every description. Messrs. Hall and Wells, specimens of their patent submarine cables and silk and cotton covered wires. Messrs. Silver and Co, various specimens of submarine india rubber cores, batteries, insulators, and other electrical apparatus, mostly constructed of ebonite. Thos. Allan, specimens of his submarine cables; James W. Brett, specimen of submarine cables; Rogers, specimens of submarine cables; the Submarine Telegraph Company, numerous specimens of submarine cables; Mr. Duncan, specimen of his patent rattan submarine cables.

The very incomplete state of the arrangements as to the display of instruments connected with telegraphy, prevents us from giving a full and complete description thereof at present. We shall feel obliged to any exhibitor who will forward a description of new or improved instruments in the International building.

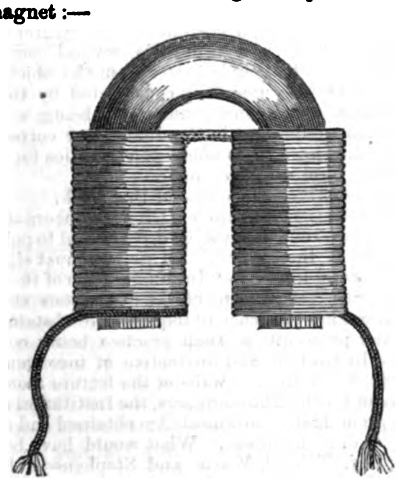
LIST OF JURORS.

CLASS. XIII.—PHILOSOPHICAL INSTRUMENTS AND PROCESSES DEPENDING ON THEIR USE.

1. Sir David Brewster, K.H., F.R.S., Edinburgh, Principal of Edinburgh University; 2. Charles Brooke, F.R.S., London, Surgeon to Westminster Hospital, 16, Fitzroy-square, W.; 3. Dr. Dove, Chairman, Zollverein, Professor of Natural Philosophy, and Principal of the Academy of Sciences, Berlin; 4. J. P. Gassiott, F.R.S., London, Wine Merchant, Clapham Common, S.; 5. James Glaisher, F.R.S., London, Superintendent of the Meteorological and Magnetical Department, Greenwich Observatory, 1, Dartmouth-place, Blackheath, S.E.; 6. Colonel Sir H. James, R.E., F.R.S., Southampton, Superintendent of Ordnance Survey; 7. G. Karsten, Denmark, Professor, Kiel; 8. Edouard Kraft, Austria, Member of the Council of Civil Engineers, Vienna; 9. Mathieu, France, Member of the Institute, and of the Bureau of Longitude, Examiner at the Polytechnic; 10. Carlo Metteucci, Italy, Senator; 11. Major-General Sabine, R.A., F.R.S., London, President of the Royal Society, 13, Ashley-place, Westminster, S.W.; 12. Wm. Thomson, F.R.S., LL.D., Professor of Natural Philosophy, University of Glasgow; 13. C. Wheatstone, F.R.S., London, Professor of Experimental Philosophy, King's College, 7, Chester-terrace, Regent's Park, N.W.

The Student.

SEVERAL correspondents have requested that information may be given in "The Student," respecting the methods of communicating magnetism to steel and *iron*. It may be necessary to state that *permanent* magnetism cannot be communicated to iron, unless the character of the metal approximates in some degree to that of steel. We have already, p. 67, vol. i., described the construction of the temporary magnet, or electro-magnet, formed of a bar or horse-shoe of soft iron, wound with insulated wire in close coils and in several layers. The soft iron becomes magnetic when a current of electricity is transmitted through the wire, but loses its magnetism almost immediately the current ceases. The horse-shoe form of magnet should be wound so that if the bar of soft iron were straightened the coils of wire would be in the same direction throughout. As, therefore, the direction of the bar is altered by its curvature, the two arms should be wound in opposite directions; in other words, when one arm has been wound the wire should be passed between the two arms before the second arm is coiled. Attention to this point will obviate failure and trouble on the part of the student. The following cut represents the coiled horse-shoe electro-magnet:—



We shall require for future experiments one or two good permanent steel magnets, both in the form of a straight bar and of the horse-shoe shape. The following brief *resumé* of the various methods which have been adopted for communicating permanent magnetism may, therefore, be practically useful, as well as instructive in regard to the phenomena of magnetic induction.

Methods of Making Artificial Magnets.

We will not, as has generally been done, pre-suppose that the student is already possessed of one or several powerful bar magnets, and wishes merely to increase the number at his disposition. There are several sources from which magnetism may be communicated, and of these we may employ at least three, according to the means at our command. If we possess neither a loadstone nor an artificial steel magnet, we may construct a powerful electro-magnet, and employ this as a source for inducing magnetism. Or, we may coil a steel bar or horse-shoe with wire, as a temporary magnet, and in this case communicate *permanent* magnetism by the passage of a powerful voltaic current. A still better and easier method is to magnetize, with the full power of the current traversing the wire, a short length of the bar or horse-shoe at a time, which may be done by passing the bar to and fro through a coil of wire, as short as possible, but as thick as may be convenient, the wire being made to convey a current of great quantity. We will, however, describe the various methods *seriatim*.

Quality of Steel Adapted for Artificial Magnets.

For small magnets, bars of well-hardened steel should be tempered by plunging at a cherry-red heat into cold water. The following general information on this point is given Dr. Scoresby:—"For all large or massive single and compound magnets of the straight-bar form, *the best cast steel* made quite hard is best; for horse-shoe magnets, if single, cast steel, annealed from file hardnes at a temperature of about 550°, or *shear steel* a little reduced; and for compound horse-shoe magnets, cast steel annealed at 480° to 500°, or shear steel perfectly hard; for compass needles, if single and heavy, such as are suited for stormy weather, *hard cast steel;* if light or of moderate weight, whether single or compound, the best cast steel, annealed at 500° or 550°, or hard shear steel, or hard cast steel from Bradford iron; and for very light needles, or other small magnets, the best cast steel annealed at the heat of boiling oil."

Magnetising Needles and Small Bars.

If a horse-shoe electro-magnet be employed, the distance between the poles should be less than the length of the needle or bar of steel. The latter should be placed on the two poles of the magnet, and moved backwards and forwards upon them several times, so that one-half of the needle is brought under the inductive influence of the north pole, and the other half under that of the south pole—the centre of the needle never passing over either pole. When the needle has been moved to and fro about half-a-dozen times, it is to be brought to its original position—with its centre midway between the poles of the magnet. The circuit traversing the coils of the latter may then be broken, and the needle removed.

Another simple method, but one which necessitates the employment of two-bar magnets, is as follows:—Place the two magnets in the same straight line with two opposite poles in contact, and lay the steel bar to be magnetized upon them, so that its centre is over the point of junction of the magnets. The latter are then drawn asunder, until the steel bar just rests with its extremities in contact with the extreme poles of the magnets. When in this position, the steel bar is removed by sliding it off sideways to some distance from the poles of the magnets, preserving its parallel position with the latter; and the magnets may then be re-united without destroying the magnetic effect already produced. The process, which occupies but a few seconds, should be repeated four or eight times—both sides of a flat bar, or the four sides of a square bar, being alternately brought into contact with the magnets.

(*To be continued.*)

PRICES CURRENT OF INSULATING MATERIALS.

GUTTA PERCHA.

Waiting for arrivals.

INDIA RUBBER.

Fine Para ...	...	...	2s. 1d. to 2s. 2d. per lb.
Negro Head	...	...	1s. 1d. to 1s. 4d. „
Java ...	...	...	1s. 5d. to 1s. 6d. „

May 22, 1862. WM. KIRKMANN,

4, Howford Buildings, Fenchurch Street, E.C.

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TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	25 to 30	——
20	Do. B per cent. till 1862 .	all	18 to 20	——
20	Do. C. " "	all	9 to 11	——
10	London & S. of Ireland Direct.	2	par.—1 pm.	——
Stock	Electric Telegraph . .	100	99 to 101	——
5	London District Telegraph .	4¾	3¾ to 3¼ dis.	——
10	Mediterranean Extension Tel.	all	3½ to 4½	——
20	Red Sea and India Telegraph	all	19 to 19½	——
1	Submarine Telegraph, scrip.	all	3/8 to 5/8	——
1	Do. registered . . .	all	3/8 to 5/8	——
10	Do. " . . .	all	4 to 6	——
2	Telegraph to India . .	1	¼ dis. — par.	——
5	United Kingdom Telegraph .	2¾	1½ to 0½ dis.	——

Colonial and Foreign Telegraphy.

TELEGRAPHS.

SHORTLY after the Appropriation Act was passed, two months since, steps were taken towards carrying out the telegraphic extensions that had been authorized by parliament. Tenders were called for the construction of the five new lines; contracts have, during the present month, been taken for them, and the works are already in hand.

The longest of the new extensions will be that from Orange to Wagga Wagga, which will connect with Sydney the Lachlan and the Burrangong diggings, and will also, by being joined at Wagga Wagga with other lines, afford a second line, independent of the present one, connecting Melbourne with Sydney. Its estimated length is 250 miles, and it has been contracted for by Mr. B. Rush at £43 per mile. Eight months are allowed for its completion.

The next longest line will be that from Grafton to Tenterfield, which will connect the Clarence district with Sydney, and also with Queensland. This extension has been contracted for by Mr. Mark Faviell at £39 per mile, and is to be completed in six months, its length being 125 miles.

An extension of the southern line from Campbelltown to Wollongong and Kiama has been contracted for by Mr. W. Monk at £38 per mile. The length of the line will be sixty miles, and four months are allowed to complete it.

A contract has also been taken by Mr. T. E. Ellis, for the construction of a line from Mudgee to Wellington, a distance of sixty miles. The price agreed on is £43 per mile, and the work is to be finished in four months.

A second wire is being stretched on the posts between Muswellbrook and Scone, a distance of twelve miles. Mr. B. Rush is the contractor, and the price agreed on is £20 per mile.—*Sydney Morning Herald.*

Recent Patents.

2661. T. MORRIS, R. WEARE, and E. H. MONCKTON, Trafalgar Square, London, "*Improvements in magnets, induction coils, and in insulating wire and metal for electric and other purposes.*" Dated 24th October, 1861.

IN obtaining electricity for carrying out this invention, the patentees employ any of the known methods, but prefer those specified in the patent granted to T. Morris, for "Improvements in voltaic batteries, and in vats used in depositing metals by electricity," dated March 10th, 1860, No. 658, and also in accordance with their patent for "Improvements in voltaic batteries for obtaining electric currents, and the products therefrom," dated September 14th, 1861, No. 2298. They make and use permanent magnets cast in suitable forms from cast iron, which are to be decarbonised by any of the known methods, so that they may be rendered sufficiently soft to fill, drill, or be otherwise operated upon; they are then to be recarbonised, hardened, and magnetised, by which means these magnets can be made cheaper and more uniform than those made from steel. With regard to coils for armatures of magneto-electric machines, where great intensity is required, and also in induction coils, the insulation should be effected in the most perfect manner, and the lengths of the wires composing the coil must, of course, be in proportion to the effect required. This novel and special method of insulation is applied as follows:—Suppose, for example, that the patentees use gutta percha as an insulating medium, a very thin layer is to be introduced to separate the first from the second coil, and also a layer introduced between each of the succeeding coils, but the thickness of the layers of gutta percha is to be increased as the number of coils is increased, and the intensity of the electric current is exalted. In short, the thickness of the gutta percha must keep pace with the intensity of the electric current as the coil proceeds in thickness.

Telegraphic News.

INSTITUTION OF CIVIL ENGINEERS.—At a meeting of the members, &c., of this institution, on Tuesday night, the 13th inst., a paper was read by H. C. Forde, Esq., on the "Malta and Alexandria Cable." The large theatre of the institution was crowded upon the occasion, proving the great and increasing interest taken in the subject of telegraphy; and also, we think, the desirability of the establishment of an institution where *electricians* could meet to discuss matters connected with the advancement of electrical science.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

ERRATUM.

To the Editor of THE ELECTRICIAN.

DEAR SIR,—I have just received THE ELECTRICIAN for May 9, and I observe that the weight of copper wire in lbs. is printed "$=qd^2$," it should be "$=9d^2$," and the diameter of No. 30 wire should be $\frac{6}{480}$. Perhaps you would be so good as to insert these errata in your next. I shall be very glad if the subject of the guages and breaking strains of iron and steel wires is taken up in your pages, as reliable information on the subject is much required.—I remain, faithfully yours, H. SCHAW.

Brompton Barracks, Chatham, 15*th May*, 1862.

SUBMARINE TELEGRAPHY.

To the Editor of THE ELECTRICIAN.

SIR,—Hearing a rumour that an application is about to be made to the Government for a grant to defray the expenses of experiments, in order to bring the long pending discussion of deep sea telegraphy to a practical issue, I write to ask the aid of your valuable paper (which is naturally looked up to as an authority on such matters) in advocating this important step. The subject is one of such public importance as to fully warrant a grant from the Exchequer, and if electricians and patentees would cordially co-operate with the Government in such experiments, surely our united experience and knowledge would lead to a practical issue, and solve the hitherto insuperable difficulties that have been met with in long sea lines.—I am, sir, faithfully yours, W. P. PIGGOTT.

16, *Argyle Street, Regent Street.*

THE JURORS FOR CLASS 13.

To the Editor of THE ELECTRICIAN.

SIR,—In the published list of Jurors, I do not recognize the name of a single practical telegraphist. It appears that the Royal Society has been honoured in its own members. Not one of the gentlemen named is favourably known in connection with submarine telegraphy, and, besides, some of the Jurors are patentees, and I believe exhibitors as well. What a melancholy feature for ocean telegraphy!—Yours, &c., J. D. L.

To Correspondents.

T. H. K.—The answer to your inquiry in our issue of May 9 was accidently ommitted. For occasional purposes of experiment, the Smee battery is very convenient, and as an electrometer it combines the two qualities of tension and quantity in the current. The iron-zinc couple (*vide* p. 259), excited with a mixture of one part sulphuric acid to 3½ parts of a saturated solution of salt, is, however, much cheaper, and gives, through a circuit offering but a small resistance, such as an electro-magnet coiled with stout wire, a current of far greater quantity. Of course, where the resistance is considerable, several couples should be associated for tension. This couple is free from the objection of "acid fumes," and may be very economically constructed by the student; all that is absolutely necessary in the arrangement being a piece of cast-iron, and one of zinc, immersed in the fluid. Our correspondent, Mr. Turton, might perhaps be able to afford you facilities for obtaining the cast-iron cells in the form we have illustrated.

A PRACTICAL TELEGRAPHIST.—Too late for this week.

C. E.—The papers read at the Institution of Civil Engineers are the property of the Institution, and no one is, we believe, permitted to publish his paper without the consent of the council. All visitors must sign a document containing the following notice:—"In consequence of the publication of unauthorized and incorrect versions of the discussions at the meetings, members and visitors are particularly requested to abstain from making any reports of the proceedings, such practice being contrary to the regulations of the Institution, and productive of inconvenience." It is rather remarkable that while the walls of the lecture room are adorned with the portraits of self-taught engineers, the Institution should place a barrier upon the promulgation of knowledge obtained and communicate through the efforts of its members. What would have been the opportunities of Brindley, Telford, Watts, and Stephenson, had they been dependent upon the increase and diffusion of knowledge by the society which is now proud of the reflection of their illustrious names?

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The Electrician.

VOL. II. No. 30.—MAY 30, 1862.

CONTENTS:

	PAGE		PAGE
Steps to Theory by the Practice of Electricity	37	On the use of Cylinders in laying Submarine Telegraphic Cables	43
"Moral Causes"	39	New Atlantic Telegraph	46
Some Considerations on the Principles of Electrical Conduction and Accumulation	40	The Student	46
A New Projectile Force	41	Prices Current of Insulating Materials	47
Royal Institution Lectures	43	Telegraphic News	47
		Correspondence	48

STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 26.]

Electro Telegraphy.

224. WHEN the telegraphist pours into one end of the wire by which he connects distant places, the electricity furnished by his voltaic apparatus, and finds part of it passing through its length to transmit his signals, while another part accumulates upon its surface to embarrass him by its inductions; he sees in violent contrast two effects of the same cause that he must desire to have separated. He feels himself to be indebted purely and simply to the dynamic current, and the static charge is to him only as the penalty he pays for it. But is it quite certain that he is compelled to submit to so great a penalty? May not the current be eliminated from the common causation while its other effect, the charge, with its induction, is being altogether suppressed? Professional opinion would answer these questions in an unfavourable manner, but our doctrines point to an opposite conclusion.

225. We shall enter into this enquiry believing its result will prove of the utmost importance, even to the extent of determining the advisability of those long lines of ocean telegraphy which modern enterprise is projecting, so far at least as theory may be held capable of determining questions of so important and practical a character; and our principles seem to be so broad and definable that the conclusion they will lead to may readily be handed over to the test of proper experiment for their confirmation.

226. Before we proceed to apply our theory to this purpose let us first endeavour, by appealing to a direct and very simple experiment, to remove an impression that appears to be very generally entertained without having its foundation in truth; we mean the possibility of conduction along a wire being a result of its charge. From what we have already shown of our view of the causation of conduction it will be understood that we cannot hold such an opinion, and it may easily be seen to be in opposition to fact.

Exp. 33. Place upon a large insulated sphere a plus charge, and against it on either side an end of an insulated horizontal rod, one of the rods being of metal and the other of glass, dry and clean. Part of the charge will immediately distribute itself over the surface of the conductor, but not over that of the nonconductor; remove the glass rod, and slide numerous parts of its surface into contact with the charged sphere, then, upon removing it, it will be found with a plus charge distributed upon those parts of its surface like the other rod.

227. In this experiment had not conduction been a preliminary necessity charge would have ensued along both the rods directly they were placed with their extremities against the charged surface of the intermediate sphere; for both the cylindrical surfaces were susceptible of charge, as is proved by the two being ultimately found plus electrical. And it has been known as a fact, ever since the times when Coulomb and Cavendish experimented, that surfaces of similar form and size, however diverse the nature of the materials, insulated in the atmosphere under like circumstances have equal capacities for charge. Facts therefore indicate, that, although it should be possible, as our theory intimates, to have conduction along a wire without charge upon its surface with the attendant induction, we cannot have the reverse of this, that is, a charge on the wire or its induction, unless the wire has previously acted in some way as an electrical conductor.

228. Let us now endeavour to explain more minutely the nature of electrical conduction along a telegraphic wire. For sake of simplicity of conception suppose the insulated wire to consist of only a single line of particles of common matter, and that we present to one of its ends a quantity of plus electricity emanating from a source maintained at a given intensity; by virtue of the shortening of distance before alluded to (par. 217), the common matter of the line, acting by ordinary electrical attractions, will attach to itself the electricity so presented. Now if the line be insulated at its further end, the electricity will be held by it as a plus charge under some intensity not exceeding that of the source from whence it has been derived; but if, on the contrary, the further end of the line be put to earth, or other sufficiently large mass of conducting matter surrounded by air, and the supply of electricity be not too rapid, then conduction and not charge, will ensue; for immediately that a particle of plus electricity enters the wire at one end, another particle of electricity natural to the other end will leave it, all the common matter of the line still possessing its normal equivalent of electricity, because every one of the common particles will have acquired an electrical particle from its neighbour situate between itself and the source of the plus charge.

229. It may be that each of the common particles in the conducting line is capable of so parting with two, three, or some great number of particles of electricity simultaneously, and in proportion as it can do so will it be the better electrical conductor, but its capability in that respect must have a limit; and instead of a single line of particles of common matter, as we have supposed, every wire will of course have some large number of such lines bundled together, proportionate to the area of its sections, from which it follows, all other conditions being constant, that its conductivity will be as its area, multiplied into the number of electrical particles that each common particle can exchange with its neighbour.

230. So far, therefore, as the wire is concerned, charge and conduction differ chiefly in this: in the former, the plus electricity of the source passes from it to the wire to act from its surface with a diminished intensity on the surrounding air; and in the latter case it is handed on from particle to particle of the wire to be conveyed to some other conductor having a charging capacity that will enable it to do the same thing, and either of these results will take precedence of the other as the surrounding circumstances shall enable it to be accompanied by the lower intensity; if the plus electricity meet with less inductive reaction by remaining in the wire than by passing out of it, charge will take precedence of conduction; on the contrary, if the plus electricity can pass out of the wire to a lesser amount of inductive reaction, then conduction will supersede charge; and therefore it is that conduction is consequent upon uninsulation, and charge upon insulation, of the wire.

231. Conduction, however, as we have already shown, must precede charge; but it may in cases of charge be a modified kind of conduction, for inasmuch as the plus electricity is then from the moment of its entering the conductor determined to its surface, it may pass thither at once without even penetrating deep into its substance, by what may be called *suffusive conduction;* that is to say, spreading with great energy over a long wire without causing any of that interchange of electricity amongst the particles which we have described as characterizing true conduction. Theoretically, this species of conduction is perfectly distinguishable from the true kind occurring in particles that can have, under the circumstances in which they are placed, no effective induction to remove the necessity for their dismissing in one direction as much electricity as they receive in another.

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232. But suffusive conduction with its consequent induction, and true conduction, may, *in the absence of a lower intensity predisposing to the latter in preference to the other*, be both set up in a conductor simultaneously. We have all along been showing how experiment supports theory in teaching that plus electrical charges act by induction with intensities that vary as the squares of their quantities; the reaction to the induction necessarily varying also in the same ratio. That law of action and reaction applies also to true conduction; for when plus electricity has to be conducted from a lesser to a larger charging capacity distant from one another, it can attach itself to each of the particles of a conductor only in quantities equal to those it virtually detaches from the particle, so that in this case, as well as in that of induction, the action and reaction, always equal to one another, both vary as the squares of the quantities of electricity *in transitu*. Hence a plus source can establish induction and conduction indifferently.

233. Now, suppose that a telegraphic wire has all the electricity that can be communicated to it at one end, solicited away by some charging capacity at the other, capable of holding it as a plus charge under an intensity infinitely small, and that the electricity be not poured into the wire from the source at a more rapid rate than it can be conducted along it; then not a particle of electricity will remain on the surface of the wire to constitute a plus charge; because it could exist there only under a somewhat greater intensity of induction than it will encounter after it passes out at the end of the wire; and this conclusion is true let the intensity of electrical action at the plus source be whatever it may.

234. We are now enabled to comprehend the means by which plus electricity may be delivered over to, and carried away from, common matter in a neutral electrical condition (par. 218); the transfer in both cases depends upon the facility thereby afforded for exchanging a greater for a lesser amount of intensity; that being a sufficient, and at the same time an indispensable, condition in this, and, as we shall understand in good time, in all other cases also of electrical action, even down to the first movements of electricity, from its state of normal repose in combination with common matter.

235. Having this insight into the nature of electrical conduction, we must proceed to consider in connection with it what observation has made known to us about the retardation experienced by electrical currents in their passage along a telegraph wire. We know in practice that the conductivity of a wire of a given nature and diameter is not the same for all lengths, and we could theoretically understand that it ought not to be so, if it depended only upon suffusive conduction, which must take time to spread; but theory seems to say also that the true conduction so far as it is concerned, ought to make conductivity uniform for all lengths, seeing that however long a conducting line may be, the transfer of electricity from one particle to another commences simultaneously at every point of its length (par. 228). We say theory *seems to say*, but it really does no such thing; for what is understood as conductivity is not restricted to the commencement of conduction; it involves, not only the simultaneous movement of electricity at every point in a line, but also the actual passing of some given quantity of electricity through all those points consecutively, and which, by reason of that consecutiveness, must occupy a period of time equal to a sum total of innumerable small units. This being borne in mind, we must next distinguish between two other things that are together present in all instances of electrical conduction, whether they be the true kind or its suffused modification. We have explained that true electrical conduction is a consequence of the definite nature of electrical attraction, made simultaneous between every two successive particles of common matter in a conducting line, by the line having placed at its opposite extremities plus electricity, together with the conditions under which it can occupy a charging capacity that involves a diminution in its actual amount of inductive intensity. Every common particle in the line, therefore, handing on to the next a portion of its own electricity equal to the foreign electricity presented to it for attraction, will be the seat of both action and reaction; but these must be equal one to the other, because the two quantities of electricity are so, and being equal, there can be no excess of either to be opposed to the conduction as a retarding force. It is evident that the same conclusion must be true also of the action and reaction present in the suffusive conduction.

236. We must look to something else for the cause of retardation. According to our theory, electricity is material, and all matter is subject to *inertia*, by which we mean that it tends to continue in motion, or at rest, according as it may at any time be in the one condition or the other. The matter of electricity must participate in the common *inertia;* and in that doctrine, we shall find a competent solution for all our problems respecting the retardation of electrical currents. It might at one time have been objected to this suggestion that electricity is exempt from inertia on account of its alleged imponderability; but it has within the last few years been subjected to the balance, and shown to be heavy, in the presence of electricians, members of the French Institute, namely MM. Becquerel (senior and junior), Pouillet, and Savary; and we shall hereafter find opportunity for adducing no small amount of evidence to establish it as the only heavy thing in nature, giving to other things their definite weights by its definite distribution among them. We may repeat here what we announced in a former place (par. 25), to the effect that we rely more on the consistency of the inferences our theory has drawn from observation, and their efficiency as a whole causative system, than upon their apparent correctness individually; and it will not be until we have had time to demonstrate the important consequences that flow from the conclusion that electricity is the cause of weight that we shall expect, on the evidence even of experiment, the public generally to be prepared to receive it as an established truth. Great changes in doctrine are only to be wrought very slowly, and it may be so in the present instance; but it will be, sooner or later.

237. But to proceed with the more immediate object of our task. Assuming that electricity tends to remain at rest when at rest, and in motion when in motion, like all heavy matter, each particle of electricity will oppose its inertia to the electical attraction when that force urges it into motion, which will, of course, be every time it has to quit a particle of common matter to go to some other similar particle. Now let us apply the principles of electrical action which we have been expounding to the electrical telegraph, that we may see in the first place whether they will enable us to comprehend its action and improve its construction; and in the second place, whether by doing so they will afford further evidence of being adequately based upon truth. We will commence by supposing that the charge to be conducted is at the near end of our wire, its further extremity being put to earth, by which, as before remarked, we are to understand that the plus electricity can be delivered into a vast charging capacity where its inductive action will be resisted by reaction infinitely small. We may thus obtain the following:—

Laws of Conductivity.

1st. The nature and diameter of the wire being given, and a definite and uniform quantity of plus electricity actually in transmission through every part of its length, the retardation experienced by the plus electricity *existing in an unit of length* will be for the whole wire simply as its length; because as that quantity of plus electricity passes successive equal units of length, it will be exposed to successive equal amounts of *inertia*, and the number of such units of length, and therefore of inertia, will vary as the length of the wire.

2nd. The nature and diameter of the wire, as well as the quantity of plus electricity uniformly in transmission through it at any one time being given, the retardation that will have been expe-

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rienced by the total quantity of plus electricity during its passage is as the square of the length of the wire; because the *inertia* for each unit of quantity of plus electricity is as the length of the wire (1st law), and this is multiplied as many times as there are units of quantity of plus electricity in the wire, and their number is as the length of the wire. But this total *inertia* cannot all have to be overcome at any one instant of time; for it must commence to be overcome with the entrance into the wire of the first unit of quantity of plus electricity, and terminate with the exit from the wire of the last unit of quantity of the plus electricity, the action beginning from nothing, gradually increasing to a maximum in middle time, and from thence as gradually declining again to nothing.

3rd. The nature and diameter of the wire being given, as well as the quantity of plus electricity in uniform transmission through it, the total retardation or *inertia*, at any given instant of time, will vary in the simple ratio of the length of the wire; because at no given time can more or less than one unit of quantity of plus electricity have to be moved from more or less than one unit of length of common matter.

4th. The natures and lengths of different wires being alike the quantities of plus electricity susceptible of being passed through them from any sufficiently abundant source of given intensity, under a given amount of retardation, will vary as the squares of their diameters; because in that ratio will vary the number of the lines of common particles carrying on the conduction, and also of the lines of electrical particles that oppose *inertia*.

5th. The nature of the wire, its diameter and its length being given, the quantity of plus electricity susceptible of being passed simultaneously through any part, or the whole of the line, will vary as the square roots of the intensities of the electricity from any sufficiently abundant source; because the intensities of the electricity from the source can liberate from any section of the conductor quantities of its natural electricity held under corresponding intensities, and the quantities held vary as the square roots of the removing intensities.

6th. The nature, diameter, and length of the wire being given, the currents through it under all intensities at the source, provided it afford a supply sufficiently abundant, will be equally retarded, and, therefore, have an equal speed of conduction; for although the quantities of the currents in any section of the wire will be unequal under different intensities, and with that inequality will exist variations in the intensity of action and reaction, the *inertia* on which the retardation depends will vary in the simple ratio of the quantities of electricity passing.

238. It will be remembered that in all these cases of conduction along a telegraphic wire we have considered the source of electricity as furnishing it in quantity just as the circumstances of each particular case required; and also that we have supposed the other end of the wire to deliver it over into a charging capacity that could receive it under an infinitely minute plus intensity. It is by the latter provision that we have maintained the conduction without accumulating charge upon the wire; in our next, when we shall resume the subject of telegraphy, we shall consider the accumulation of charge with particular reference to these several laws of electrical conduction.

(*To be continued.*)

"MORAL CAUSES."

It cannot be denied that the promoters of enterprise in submarine telegraphy, and those who have taken the most prominent part in carrying their projects into effect, have occasionally been open to serious imputation. Although it might be argued that this fact by no means constitutes an exceptional case, when compared with what occurs in other professions, it is painfully evident that the status of submarine telegraphy has been lowered by causes which are "beyond the sphere of scientific knowledge and mechanical skill." Even now, those who act for the public, and who are so placed that their interest is identical only with the progress in the abstract of telegraphy, are sometimes, amid the expression of conflicting interests, inclined to ask themselves the question, "Whom can we trust?" In truth, the confidence of Government has been more than once misplaced.

We need not repeat the terms expressive of reprobation which have sometimes been applied to proceedings connected with telegraphy and more particularly involving important pecuniary considerations; nor need we too closely examine the past before surveying the present moral position of telegraphy, or glancing at its future. Our theme, like that of CHAUCER'S *Pardoner*, would be "always one"—

"Radix malorum est cupiditas!"

Nevertheless, we do not shrink from giving the lash where it is most wanting, or from pointing a moral which by some may be read with different feelings, and with different profit, to those which will be experienced by the generality of our readers. Telegraphy has been until lately an art occult even to many of the votaries of electrical science. Submarine telegraphy, initiated by a bold tentative process—the laying of the Dover cable in the year 1850, opened out a vast field of opportunity both to merit and competency, and to unscrupulous determination. For the purposes of the latter, the field was to be kept close, and science, which can alone be secured by merit, more or less ignored. To this end, two things were necessary—combination and a counterfeit. The combination would secure unity of action to various preponderating influences, a pretentious counterfeit was to place the science of telegraphy beyond the reach of interference from the uninitiated. *Nous avons changé tout cela*, but meanwhile what has happened? Who gave to the late President of the Institution of Civil Engineers, and to others who occasionally have spoken to the same purport through the medium of the press, the occasion to reflect upon the "moral causes" which have operated to the detriment of telegraphic extension? By whom have been mainly secured the large sums which have been expended ineffectually upon this object? The question can be answered by those who have followed even cursorily the history of submarine telegraphy. It is not in one instance only that self-interest and exclusiveness have been prejudicial to a class of undertakings which can only prosper where such considerations are disregarded or over-ruled; but there are few who will not remember the case, *par excellence*, of the Red Sea cable, the peculiar nature of the association in this instance, and the unaccountable perpetuation of the same superintending agencies in the case of the Rangoon cable.

The satirist might have taken notes of two descriptions of scientific "make-believes," consequent upon the sudden acquisition of immense importance by enterprises in submarine telegraphy. The first, and perhaps the most respectable, was formed of those who had the advantage of acquirements perhaps equal to those of men who earnestly and unaffectedly devoted themselves to the study of the electrical conditions in submarine lines. But these conditions were so little understood by those who might have popularized and disseminated information on the subject, that the most pretentious claimant of proficiency was certain, at least for a time, to secure the greatest amount of credit and attention. Hence the scientific counterfeit which delighted in complication and abstruseness, and which for a long period maintained by these means a degree of exclusiveness. Such pretension would have been comparatively harmless, and must have gradually approximated to the ridiculous, had it not in some instances been maintained by artifice, and even by absolute trickery. We have known the perpetration of solemn scientific mockeries in the way of testing submarine cores; the application of "improved and searching" methods, under which the per centage of rejected lengths, accidentally or purposely

submitted as fresh samples, were unaccountably "passed" as good or moderate, instead of bad or defective. And we have heard of a length of wire being so submitted to test, in order to prove the perfection of a particular process, that, by sleight of hand, a portion only of this length was contrived to give the data for the insulating properties of the whole.

The second class of "make-believes," very influential in their own particular sphere, was composed of men, who, with no acquirements of any kind, based their pretensions upon the grounds of an assumed "experience." Their "experience" of submarine telegraphy, as an accomplished and unalterable fact, with which in some capacity they had become acquainted, rendered it unnecessary or impossible that they should extend the sphere of their knowledge on this subject. To them belonged the smile of incredulity when the probability of any improvement, or the results of new investigations were referred to; the complacent contempt for "theory;" the shake of the head, fraught with profound wisdom; and all the convenient methods by which incompetency avoids going beyond its depth, whilst preserving the outward appearance of sagacity. *Ars sine artem, cujus principium mendicere!* On such easy terms was it possible to maintain a "scientific" reputation against all new comers.

But this country has reason to be proud of those who at the onset entered earnestly into the study and investigation of the conditions necessary for the extension of telegraphy. These men have done as much to advance the science of electricity in its practical bearings as to forward the art of electro-telegraphy in the point of view of science. With some few honourable exceptions, the world can look only towards our electrical engineers and electricians, for the benefits to be derived from the extension of the system of ocean telegraphy. Not merely as a business or a profession, but as the practical application of science necessitating the highest qualifications of knowledge, has telegraphy been studied by many during the last few years. The stimulus towards progress has not possessed simply a commercial aspect. The same feeling has once or twice been shown in other matters of equal importance—notably in the employment of steam as a motive power. In such matters, one great object of the promoters of progress has been to bring others to the knowledge and appreciation of the opportunity which they were among the first to perceive and understand. They desire that all who may should contribute their support, morally, intellectually, or physically, to the objects in view; and they look to others, as well as to themselves, for the means of progress. On the part of such men there has never been any exaggeration of their own qualifications, or mystification as to their own resources. Here we have a "moral cause," the beneficial influence of which will ultimately be felt. It remains for those who act for the public to bring this influence into activity. Those in whom the higher motives of science have been evidenced, may safely be trusted even in matters where there is an option between a private interest and a public benefit.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

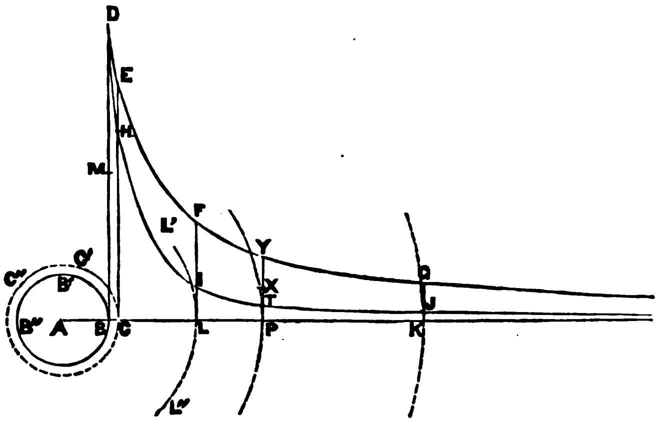
BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 29.]

Let A B (fig. 60) be the radius of a cylinder, having hemispherical ends, and let B D represent the resistance of an indefinitely thin layer of dielectric round a portion of the cylinder having a surface equal to the surface of the hemispherical end; then B D will also represent the resistance of an indefinitely thin layer over the hemispherical end.

Then from what has already been shown with regard to cylindrical and spherical resistances, the resistance of the dielectric between the unit of cylindrical surface and any outer opposing surface L L′ L″, will be represented by the space B D F L, (the curve D F G being an hyperbola, with A K as assymptote;) and the resistance between the hemispherial end and the outer surface L L′ L″ will be represented by the space B D I L, (the curve D H I J being taken with its ordinates inversely as the squares

Fig. 60.



of the abscisses having their origin at A.) From this we also see that the smaller the distance between the inner and outer surfaces is compared to the radius (A B) of the inner surface B B′ B″, the less will be the difference between the resistance of the dielectric separating the cylindrical surfaces, and the dielectric separating the hemispherical surfaces.

For if A C represent the radius of the outer surface, then the space D E C B represents the cylindrical resistance, whilst D H C B represents the hemispherical resistance, the difference between which is only the space D E H. If A L be the radius of the outer surface, the cylindrical resistance is represented by the space B D F L, and the hemispherical resistance by the space B D I L. The difference between the two resistances being the space D E F I H D. It is evident that the ratio between D F L B and D I L B $\left(\text{or } \frac{\text{D F L B}}{\text{D I L B}}\right)$ is greater than the ratio between D E C B and D H C B or $\left(\frac{\text{D E C B}}{\text{D H C B}}\right)$. And if we suppose the radius of the outer surface to be still greater as A K, the ratio between the two resistance will be still greater.

It is evident, therefore, that the outer opposing surface may be at such a distance that the inductive resistance between the cylindrical surfaces will be double the resistance between the hemispherical surfaces; then the quantity and density on the hemispherical surface of A will be double the quantity and density on the cylindrical surface. This occurs approximately when the radius of the outer surface is $4\frac{1}{2}$ times the radius of the inner surface. The density on the hemisphere, in such case, would be double that on the cylindrical surface. The quantity on the outer cylindrical surface will be of course equal to that on the inner one, but as the surface of the former is $4\frac{1}{2}$ times greater than the inner surface, the density will be $\frac{2}{9}$ that of the latter.

In the same way, the density on the outer hemispherical surface will be $\frac{4}{81}$ that on the inner spherical surface.

Thus if A P (figs. 60 and 61) represent the radius of the outer surface equal to $4\frac{1}{2}$ times A B, and B′ M ($= \frac{1}{2}$ B D) represent the density on the cylindrical part of the conductor, then B D (= 2 B M) will represent the density on the hemispherical portion; P X (= half P Y, fig. 60,) will be the density on the cylindrical part of the outer opposing surface, and P T the density on the hemispherical part of the outer opposing surface.

The distribution on the two surfaces would thus be represented approximately by the dotted lines M M D D and X X T T (Fig. 61). It is evident that the change of density will not occur abruptly, but in a gradual curve, somewhat as represented, because the two surfaces cannot be separated entirely into two distinct resistances, the one strictly cylindrical, the other strictly

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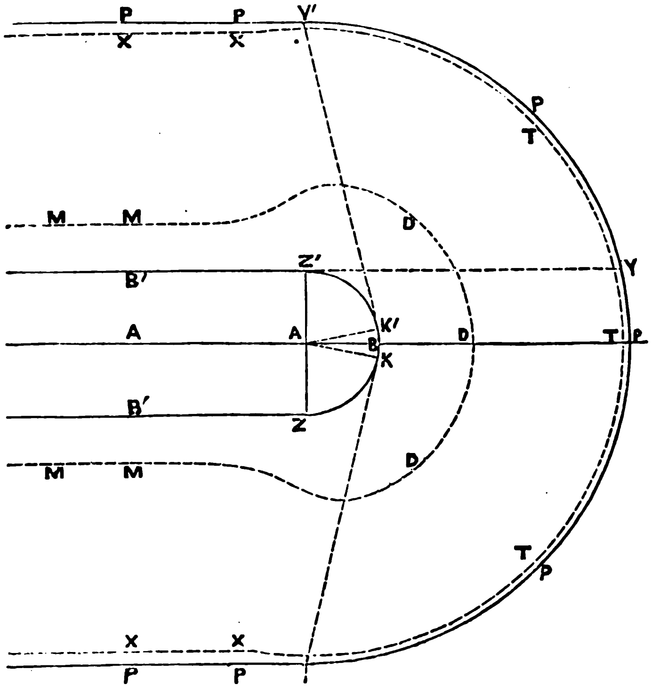
hemispherical. Thus the part of the inner hemispherical surface situated between K and K′ is the only part of that

Fig. 61.

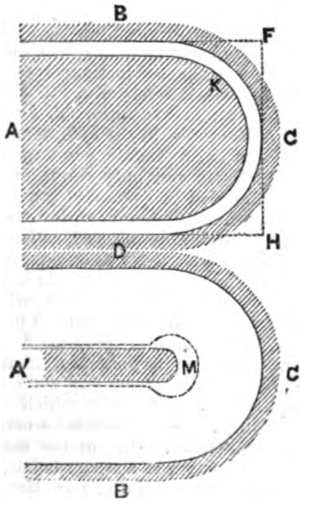


surface which is opposed entirely by an outer hemispherica surface, the parts between K and Z and K′ and Z′ being more or less opposed by a portion of the outer cylindrical surface. In the same way, every part of the cylindrical surface is more or less acted on by the hemispherical surface Y Y′, those points of the cylindrical surface the more proximate to Y Y′ being the most affected.

The less the radius of the outer surface compared to the inner the nearer will the hemispherical and cylindrical resistances over a given area approach to equality, and consequently the more uniform will be the distribution, whilst the greater the radius of the outer surface is, as compared to the radius of the inner surface, the more unequal will be the distribution, which will consequently be greater on the hemispherical surface than on the cylinder, although beyond a certain distance a further increase of distance will produce but little alteration.

Thus if A (fig. 62) represent a portion of a cylindrical con-

Fig. 62.



ductor with hemispherical ends, having an outer opposing surface, B C D, then, as this outer opposing surface is only separated by a small distance from A, as compared to the radius of A, the distribution of a quantity of electricity imparted to A will be much more uniform than the distribution that would take place on A′, where the outer surface D C B is separated from A′ a considerable distance as compared to the radius of A′, and in which case the density will be much greater at the hemispherical end of A′ than at any other part, and the distribution would be approximately represented by the dotted lines.

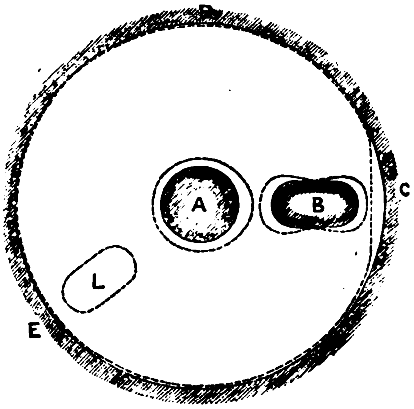
By similar reasoning, it is easy to perceive that in the case of a conductor having a protruding portion ending in a point, the inductive resistance between the point and the surrounding surface (supposing the latter of the same form as the conductor) will be very small compared with an equal surface of any other part of the conductor, and consequently the greatest accumulation will occur at the point. For similar reasons the accumulation on the edges of a disc, and the portions of its flat surfaces in proximity to the edges will be greater than on the more central parts of the flat surface.

If, instead of the inner surface, or surface of a charged conductor protruding to a point, the exterior surface approaches in one place much nearer to the interior surface than at any other, the inductive resistance will be diminished between the nearest parts of the two surfaces, and the accumulation will consequently be greatest at those parts.

Again, if, instead of either surface approaching towards one another at one particular place more than at another, an intermediate uncharged conductor is introduced between the two surfaces, without touching either, it will become polarized, and the inductive resistance will be diminished between those parts of the two surfaces between which it is situated.

Thus, in Fig. 63, if A be a positively charged conductor, sur-

Fig. 63.



rounded by the surface D C E, which will consequently be negative, and B be an uncharged conductor, then the inductive resistance will be less in the direction A C than in any other direction, and the charge on A will have its greatest density on the parts most proximate to B, B will be polarized and be negative towards A and positive twards C; and the surface C D E will have its greatest density at C.

If now another conductor L be introduced, the inductive resistance will be diminished in the direction A E, and a fresh distribution of the charge on A, and the opposite charge on D C E, will take place in accordance with the altered resistances in different directions separating A from D C E.

A NEW PROJECTILE FORCE.

BY THOMAS M. MESCHIN, D.C.L., F.S.A., OF THE INNER TEMPLE, BARRISTER.

[Continued from p. 34.]

THE electric gas gun is eminently suited for being wrought by machinery, thereby securing greater precision of aim, greater rapidity in firing, and enabling one man to accomplish the work of many. The recoil of the

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gun might also, if necessary, be turned to account in increasing the condensation of the gases, and for the purpose, when requisite, of forcing water into the gas generator when the weapon is in action, to replace that consumed by discharging the weapon. This may be accomplished by a plunger, similar to that of a Bramah press, moving in the plane of the recoil.

An electric-gas gun, if wrought by machinery, might be made to cover an object as accurately and with as much precision as a theodolite, the rapidity of its discharge might be made to rival, or surpass, that of a revolver, only it would be continuous, and not limited, as in a revolver, to half-a-dozen rounds, and it would be as much under the control of one man as the most gigantic of our steam engines. The machinery for the weapon might be wrought by a donkey engine, the cylinders of which could be supplied from the gas generator, in the manner mentioned below. In a fortress, or ship, defended by a few such weapons, one man might do the work of fifty.

In the interests of peace, it is no small recommendation in favour of these weapons that they are more calculated for defence than for offence.

The steam gun, as is well known throws its projectiles with great rapidity. Now, if these gases, of which I have been speaking, were substituted for steam they would be much more efficient; firstly, because a higher pressure could be obtained with much less danger; and, secondly, at the moment the projectile was leaving the tube or barrel the gases might be exploded, thus impressing upon the ball or projectile an augmented force fifteen times greater than that to which it is subjected in the American steam gun; consequently the ball or projectile would be at least fifteen or sixteen times more effective under the action of the gases in an electric gas gun, than it is under the action of the steam in the steam gun.

A cubic foot of water produces at the mean pressure about 1,980 cubic feet of the mixed gases—that is, about 1,320 cubic feet of hydrogen gas, and 660 cubic feet of oxygen gas, or nine pounds of water produce eight pounds of oxygen gas and one of hydrogen. A cubic foot of water produces 1,700 cubic feet of steam at the mean pressure 212° Fahr. The relative volume of the gases, at that pressure and temperature, would be 2,572 cubic feet, so that the advantages are on side of the gases in this point very decidedly.

In a fortress defended by these weapons there would be no need to tremble for the safety of the gunpowder magazine, and the apparatus for supplying the electricity might be placed out of the reach of harm. And now as to cost, after the first cost of the requisite apparatus has been defrayed, the cost of maintaining the electrolysing action in the gas generator, will mainly depend, if voltaic electricity be used, on the value of the materials consumed in the battery, as compared with the value of the products of the battery. If common electricity be employed, its cost will be measured by the amount of mechanical effort necessary for its development. If magneto-electricity be used, its cost will depend upon the mechanical force requisite to keep the magneto-electric machines in action. If thermo-electricity be employed, its cost will depend upon the expense incurred in keeping the extremities of the bars of the thermo-electric piles at different temperatures.

The advantages of these electric gas guns, as compared with gunpowder guns, are:—

1. The projectile force employed is very much cheaper than gunpowder.
2. Its practice is more certain and uniform, not being liable to be affected by damp, &c.
3. It is more under control; the force with which a projectile is driven may be diminished or augmented at pleasure.
4. It is capable of being wrought by machinery (driven by the gases from its own gas generator), thereby ensuring greater precision of aim, greater rapidity of firing, and enabling one man to do the work of many.
5. It is less dangerous, both to the men who work it, and to the ship, or fortress, which it defends, as it needs no powder magazine, which might be blown up by shot, shell. or lightning.
6. A force is applied to the projectile more favourably, resulting in less strain upon the weapon, and its greater durability; besides, not being liable to be heated, it is the more perfect weapon, being capable of more incessant and prolonged work.
7. The discharge being accompanied with neither smoke, flame, nor report, it could not afford a marked object for the enemy's shot.
8. Its superior powers of horizontal or point blank firing at low elevations, "the best test of the real power and value of a gun," "its real service value."

The Electric Gas Shell.

These gases, evolved by the decomposition of water by electricity, may be forced, at a very high pressure, into metal shells, similar to shells used for offensive operations in war, the shells being so constructed that on striking any body, an electric spark, or detonating spark, could be elicited, which would result in the detonation of the gas and the bursting of the shell.

Then these gases might be used with other bodies in the shell, gaseous, liquid, or solid, that would contribute to augment the violence of bursting.

A NEW MOTIVE FORCE.

When gases are maintained at a high pressure or tension in a vessel, corresponding to the boiler of a steam engine, they will, if admitted into a cylinder, press upon the piston, and perform all the functions discharged by steam in working an engine.

Electric Gas Engine.

Gases generated under a high pressure, by the decomposition of water by electricity, will act fullly as effectively as steam when admitted into the cylinder of a steam engine. The pressure may be raised to a point at which it would be perilous to work steam, owing to the facility with which the strength of the reservoir may be increased. Then, no additional cost is incurred by working at the highest pressure; precisely the same electro-motive force is expended in effecting decomposition at all pressures. Thus the strength of the gas-generator is the only practical limit to this enormous force, the real obstacle to its most economical application, an obstacle which, doubtless, will gradually yield to the ingenuity of engine manufacturers,

These gases may be wrought expansively, which will result in very great augmentation of the work done by the engine, for the same expenditure of electro-motive force.

After the gases, by passing through the cylinder, have impressed upon the piston the force due to the pressure under which they are generated, they may be utilised in either of the following ways:—

I. By detonating the gases after they have expanded; while in the cylinder, they may be combined by an electric spark. In combining they expand to fifteen times their bulk, and, consequently, impress a force on the piston equal to fifteen times the pressure which the gases exerted. A heavy fly-wheel would prevent the loss of *vis viva*, which might attend the suddenness of the application of this force.

When the gases are combined by an electric spark, they are converted into water, and a vacuum results similar to that occasioned in a condensing steam engine by the condensation of the steam. By the vacuum which is thus formed by the combination of the gases, the advantages of the high-pressure and condensing steam engines may be combined in the electric-gas engine.

The sources of force are, therefore, threefold.

1st. The high pressure is the gas generator, which may be taken at 50 atmospheres, or 736 lbs. to the square inch, although in high-pressure steam engines it rarely exceeds 120 lbs. There can be little doubt but that the reservoir may be readily constructed sufficiently strong to work safely at a pressure of 60 or even 100 atmospheres, particularly when all the inducements which economy can hold out are on the side of high pressure in the electric gas engines.

2nd. The expansion of the gases to fifteen times their volume exerts a force on the piston.

3rd. A vacuum which will give a useful effect of from 13 to 14 lbs. per square inch.

II. The combustion of the gases after passing through the cylinder, may be employed for heating the gases in the cylinder while expanding. and thereby increasing their elastic force; it is obvious that this heating process must be applied while the gases are in the cylinder, for no advantage would accrue from increasing their tension in the gas generator, as they can be evolved at the highest possible pressure there without additional expense, but if they be heated while expanding, it is obvious that the work done by them would be much increased.

III. By burning the gases after passing the cylinder, for the development of thermo-electricity, to be employed in aid of the electricity used in decomposing water in the gas generator.

IV. By using the gases after passing through the cylinder for the purpose of developing electro-motive force, to go in aid of that employed in decomposing the water in the gas generator; theoretically, the electro-motive force developed by the combination of the gases ought to decompose an amount of water equal to their own weight. This is, I believe, the theoretic effect of Grove's gas battery.

Thus, then, the gases, after being used in the cylinder, may be employed in one of three ways:—1. For the production of an electro-motive force by thermo-electricity or by voltaic-electricity. 2. For the production of a detonating force, and the resulting vacuum. 3. For increasing by their combustion the tension of the gases in the cylinder.

It may be observed, that in an electric gas engine the gases may be wrought expansively, which will not only result in considerable saving, but will also materially diminish the possible practical inconvenience of the detonation of the gases in the cylinder; if, for example, the gases were wrought at 50 atmospheres, and were allowed, before being detonated, to expand in the cylinder till the pressure was one-quarter of an atmosphere, the pressure on the piston when detonated, would le less than one-twelfth of the inital pressure of the gases in the cylinder; what the proper amount of expansion to be allowed is, would very soon be practically determined, when the electric gas engines come into operation.*

The strength of the reservoir, or gas generator, in an electric gas engine, corresponding with the boiler in a steam engine, might be increased to almost any amount required; the difficulties which prevent the strength of a steam boiler from being increased beyond a certain point could not operate as regards a gas generator. One of the main objects kept constantly in view in the construction of a steam boiler, is the securing the largest possible amount of heating surface; now the strength of a boiler

* See Appendix II., p. 415.

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is the strength of the weakest part of it, consequently, as its surface is extended, the chances of a flaw or weakness in some part of that surface are increased; then, if the thickness of the plate were unduly increased, it would interfere with the action of the fire. The riveting of the plates is estimated to reduce the strength one-third. The highest tension attained in high-pressure steam engines scarcely, if ever, exceeds eight atmospheres, or 120 lbs., per square inch; in an electric gas engine, the highest pressure may be maintained in the gas generator at precisely the same cost as the lowest; consequently, the higher the pressure the less the expense for equal amounts of work done. With regard to the construction of the reservoir, or gas generator, the form of greatest strength may be adopted, and the thickness of its parts augmented to any conceivable amount.

If necessary, to obviate any danger that might possibly arise from the accidental detonation of the gases in the gas generator (if such a thing be possible), the gas generator may be divided into two compartments, in which each gas may be kept separate, thus rendering such a detonation wholly impossible. With regard to the cylinder, it may, if found requisite, be divided, during the first part of the stroke, into two separate compartments, proportioned in capacity to the respective volumes of the two gases, but so as that during the latter part of the stroke, the gases may become mixed, so as to be, if necessary, detonated by an electric or other spark.

The time must come, if it has not already arrived, when electricity will be produced more cheaply than steam. Every mechanical and chemical change which takes place in bodies, results in setting free some electricity; thus, if two bodies are in contact, and they are suddenly removed, there is an electrical disturbance. When water boils electricity passes off in the steam. The fire in the grate and the flame of the gas-lamps are evolving electricity.

Every chemical change in the constitution of bodies results in the development of electricity. A galvanic battery merely collects and applies the electricity evolved by the chemical changes going on in its cells. If some method could be discovered of making the products of the chemical action in the battery as valuable, or nearly as valuable, as the zinc or other agents of which the battery is composed, the great problem would be solved, and electricity might take its place side by side with steam as a practical motive force.

In conclusion, I may observe that the proposed electric gas engine and electric-gas gun are original ideas. It first struck me that electricity might be used as a motive force about 1849, when attending the lectures of a most able and amiable gentleman, whose admirable "Treatise on Heat" ranks him high amongst modern philosophers.

I may also, perhaps, mention that I gave notice, before the meeting of the British Association in last September, of my intention of reading a paper on this subject, but was prevented, by unavoidable circumstances, from going to Manchester.—*From the Journal of the Society of Arts.*

ROYAL INSTITUTION LECTURES.

Dr. Lyon Playfair, C.B., is continuing a course of six lectures, his subject being "The Progress of some of the Chemical Arts between the two Great Exhibitions of 1851 and 1862." After some preliminary remarks on the great additions to the powers at the disposal of man gained by the recent numerous applications of science to industry, such as the substitution of steam for animal labour, the economy of time, and the utilisation of waste materials, he entered upon an account of the distillation of coal, with especial regard to the production of illuminating gas and the formation of paraffin. He referred to the sacred fire of the Persians as being due to inflammable gas issuing from the earth; to the experiments of Dr. Clayton on coal, about 1739, who exhibited the "spirit of coal" in bladders, and burnt it in small jets; to Sir James Lowther, who collected gas from the coal-measures on his estate, and burnt it as it issued from tubes; and to the ideas put forth by Lord Dundonald, about 1786. Murdoch, however, was the first to manufacture this gas, and use it for lighting purposes; Winsor, in 1812, cultivated its use with great enthusiasm; and, above all, Clegg exerted himself most successfully in devising methods for purifying the gas, and depriving it of many injurious properties. By means of diagrams and models, Dr. Playfair described the process now in use in gasworks, showing the formation of the gas in the retorts, the deposition of the tar it contains in the hydraulic main; its progress through the condensers and purifier till it arrives in the gas holder; and, finally, the regulation of its distribution by means of the "governor." The chemical character of the gas was dilated on, and it was shown that its illuminating power is due to the quantity of the hydro-carbon, termed olefiant gas, which it contains. Attempts are now being made to produce a cheap light, by communicating additional illuminating power to pure hydrogen gas, by combining it with a hydro-carbon, such as naphtha. This, however, requires great care. Dr. Playfair also referred to the improved mode of purifying ordinary coal-gas by passing it through sawdust and oxide of iron, the latter substance taking up the sulphur, a most objectionable ingredient. The lecture concluded with an account of the production of paraffin oil and wax from coal, especially from Boghead coal, concerning the nature of which there has been so much litigation. This paraffin, it was stated, is merely the solid and liquid form of the hydro-carbon "olefiant gas," which is obtained from the distillation of coal and peat. In 1841, Liebig condensed this gas into wax and oil; and at the Exhibition of 1851 only one paraffin candle was exhibited. In the present exhibition there are large blocks of paraffin, and numerous specimens of candles, the manufacture having become of very great extent. A great number of coal products were placed on the lecture table. In the next lecture the application of the waste materials of the gas manufacture in producing salts of ammonia, colours, &c., will be considered and illustrated.

ON THE USE OF CYLINDERS IN LAYING SUBMARINE TELEGRAPHIC CABLES.

A PAPER READ BY CAPT. J. SELWYN, R.N., BEFORE THE UNITED SERVICE INSTITUTION, MAY 2ND, 1862.

[We are indebted for the opportunity of giving this paper *in extenso* to the courtesy of the Council of the United Service Institution.]

It so happens that no longer ago than yesterday, an article has been written to the *Times* on the question of the Atlantic telegraph cable, which is still occupying public attention, although for the moment its accomplishment seems to be rendered more difficult by the unfortunate circumstances which have plunged the American States into the horrors of civil discord.

It will be easily conceded that novelties of structure are most useful, and are therefore generally most required when novel operations have to be entered upon. No enterprise of this age has greater claims to novelty than that which has sought, which still seeks, to establish telegraphic communication, by a submarine cable, between the Old World and the New.

I claim, without fear of contradiction, the solution of the problem, as far as the laying of such a cable is concerned, as the birthright of the seaman; and I am now here to ask the attention, and attempt to merit the approval, of my brother seamen, while I propose what I must acknowledge is a novel, and I hope they will think is a seamanlike, means of performing the difficult task which I have just claimed for our profession.

Neither seamen or fishermen will have much hesitation in granting that the best of all ways of getting a long line laid out free and clear, is to run it off a reel; and our invariable practice at sea in such cases is to use reels, whenever they are possible. Thus, when the question was first mooted of laying a cable, comparatively a mere thread, across the Atlantic, it is no wonder that Brunel (on being appealed to for his opinion) should have advised the use of a reel. But how to carry such a reel as would be necessary? This was held to be a fatal objection at the time, but I am now, I hope, about to show how it may be overcome. Your reel may be made in the form of a cask, or cylinder, and then it will "carry itself," *i.e.*, float, with the cable reeled upon it. It may have paddle wheels on the ends, and be set in a frame by which it may be towed, revolving as it passes through the water. The model cylinder, which you see on the two lines stretched across the platform overhead, represents the form I propose.

I am sorry there is no water here sufficient to float it, and seamen are generally supposed to be at their wits' end in the absence of that element; but yet, as we ought to be always ready to take a lesson from anyone, I have thought I might here take a lesson from Blondin, and substitute a tight rope for the sea.* It is almost as dangerous, and therefore may in some other respects be likened to it, and it happens to answer the purpose in showing the unrolling, and consequent descent of the cable, moderately well.

I grant that this will have to be a big cask, but perhaps not so big or so unwieldy as would at first sight appear probable. First, what is the weight and size of the cable to be carried? I will take the late Atlantic cable as a specimen. This weighed in air, 1 ton per mile; in water, 14 cwt. Its diameter was $\frac{5}{8}$ths of an inch. Suppose we have to carry 1,500 miles of such a cable, and in round numbers we will say it weighs 1,500 tons, (neglecting the specific gravity.) I cannot tow my reel conveniently as I should wish, if it is more than about $\frac{4}{10}$ths immersed; so I want more than double 1,500 tons, as the carrying power of the cask, cylinder, or reel. I find by calculation that a cylinder 60 feet long by 50 feet in diameter will have a tonnage of 3,386. Four-tenths of this is 1,354 tons, leaving 146 tons to make up the 1,500 tons, which must be accounted for (if I do not desire to increase the size of the cylinder) by the different specific gravity of that portion of the cable which is immersed. This will easily be done, if we consider that the gain from this cause will be equal to 406 tons, or there will be a diminution of the weight, to that amount, of the $\frac{4}{10}$th of the cable, which will be immersed. The diagram, No. 1, shews the proportion which

* Two lines were tightly strained across from gallery to gallery, and on those the cylinder revolved as it was drawn along, and paid off the cable below. See fig. 1.

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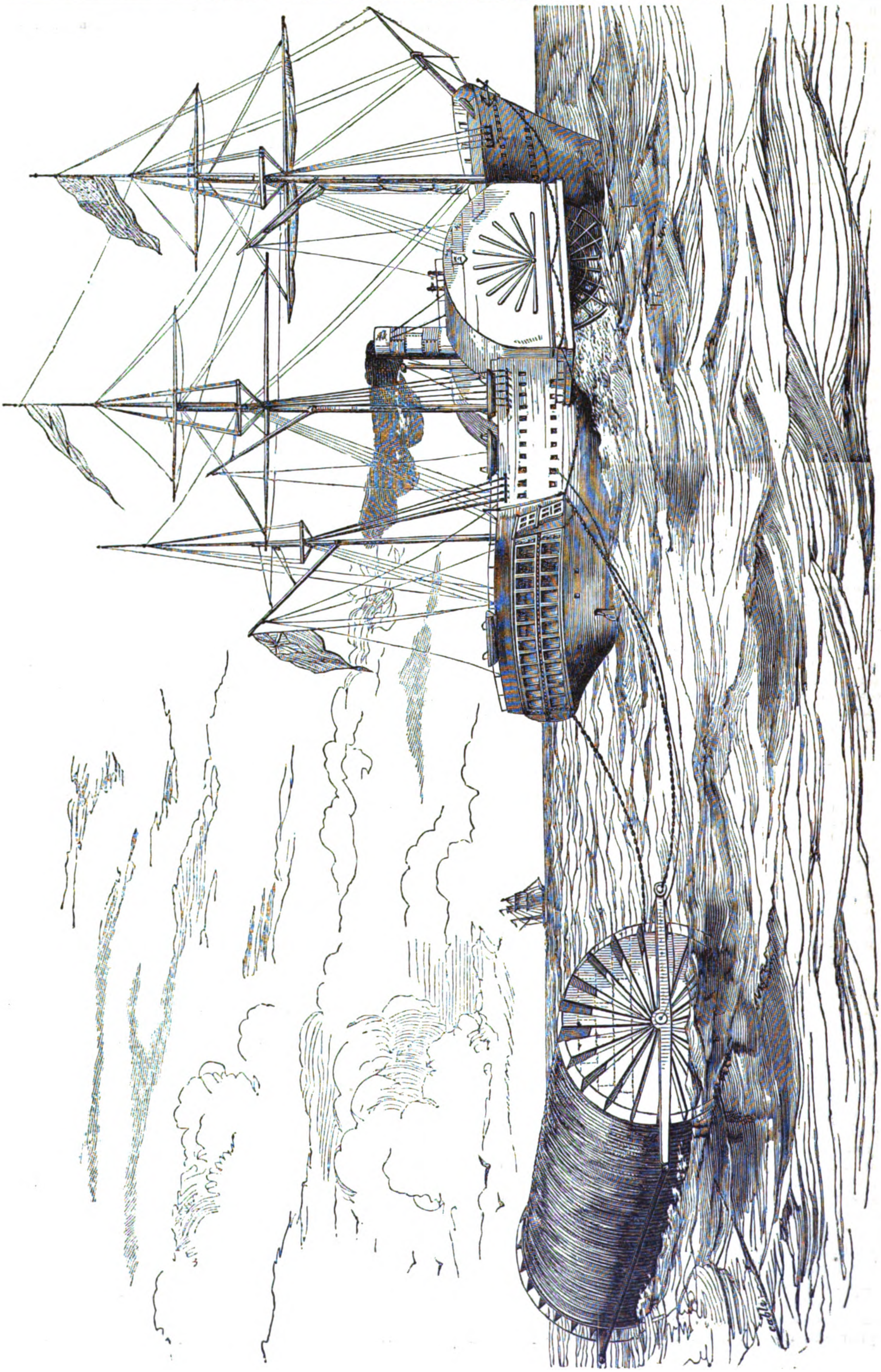

Fig. 1.—CAPTAIN SELWYN'S SYSTEM FOR LAYING SUBMARINE CABLES.

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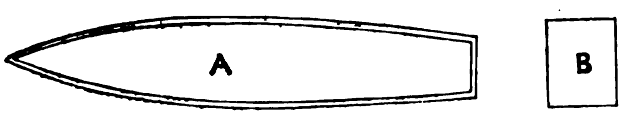
a cylinder bears to the ship towing it. The cylinder shown there is one calculated to carry a cable which has less specific gravity, and less weight, but which is one now generally approved of, and which, I have little doubt, must eventually be used. It is designed and constructed by Mr. Allan, and

Diagram, No. 1.

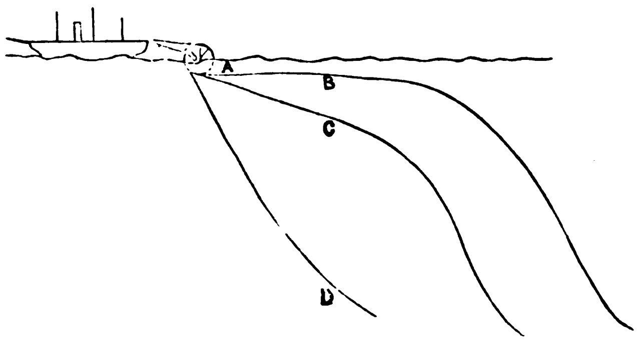


A, ship 300 ft. long 50 ft. beam. B, cylinder 50 long 30 diameter.

specimens of it are upon the table. That cylinder, therefore, has a diameter of 38 feet only, by a length of 50, which gives a tonnage of 1,628, and is fitted to carry a cable whose weight in air is 10 cwt.—in water 4 cwt.—and diameter ½-inch—length now thought sufficient, 1,000 miles. This, for two cylinders, will be 2,000 miles; the distance is 1,650 nautical miles, and this will, therefore, give a slack amounting to 20 per cent., which is ample. Now, as to the space occupied by the cable when reeled on, I find (referring still to the old Atlantic) that for 1,500 miles of it, ⅝ths in thickness on a cylinder whose diameter is 50 feet, and length 60, there will be in the 60 feet 1,158 turns, making one fake or layer of 31 $\frac{6}{10}$ miles, and that of these layers there will be 48, making a total thickness of two feet 4 inches only. In no other way can you stow it as neatly, or in so small a space; and you can reel it on evenly and quickly by mooring the cylinder off a wharf, and either have steam engines on the wharf to set the cylinder in rotation, or use your paddle wheels, which, as shown in the model, are attached to the ends to do the work. As the tide or stream passed the cylinder, it is evident that it would operate on the paddle wheels and cause rotation. The principal object of the paddles is, however, not this. You will observe that they are not moveable, independently of the cylinder; that they are, in fact, fixed to the cylinder and its axles, as I have explained, therefore, if subjected to the action of a current of water, they would cause the rotation of the cylinder. But, what will be their action while the cylinder is being towed forward by the ship? What would be the result if they were not present? The end of the cable being once let go, or allowed to sink, the whole cable would run off unchecked, and deposit itself in a coil on the bottom; but the paddles will prevent this by beating the water and causing forward movement of the whole body. It appears, then, that the weight of cable is, as a constant clock weight, taking the place of steam in producing motive power, and capable of relieving the ship towing under certain circumstances of a portion of the work. But this action, whatever its amount, is co-existent with another. Whether, in a current, the water passes by and infringes upon the paddles, or whether, as in towing, the body to which the paddles are attached passes through the water, the result is the same, namely, the rotation of that body. So, as the cylinder is towed forward, the cable is thrown off with an acceleration due to the weight of the cable, and a retardation due to the diminishing diameter of the reel, as compared with that of the paddles. There is also another compensation. As the cable is thrown off the cylinder lightens, and less resistance will be opposed by the paddles to the dragging off of cable. But, coincidently, the depth of water, and therefore the weight suspended, will have diminished, and therefore the diminution of resistance is only what would have been required. The motive power, which I have spoken of as being derived from the weight of cable suspended, was remarked upon immediately by a friend, whose opinion I early sought on the subject, Mr. Gravatt, F.R.S., a mathematician, whose name need only be mentioned to ensure respect for his dicta on such a point. He said, as soon as he saw the model, "Why, it will run over the ship." It was true enough, if the ship had not had steam power sufficient to get out of the way; but on going more into the matter we found that this would be the action. If you could only go as fast the cable could sink, *i. e.*, about two miles per hour, then the weight of cable would assist the towing. If you went faster than this, then, owing to the angle at which the cable descended being altered (growing more astern), it would not help the cylinder forward at all at a high speed, and less as the angle with the horizon decreased, after the angle of 45 is passed (see diagram, No. 2) the backward pull exceeds the forward impulse, and *vice versâ*. Thus, I neither mean to propose to you that the cylinder should lay its own cable, nor do I fear that it should run over the ship, although these forces will be acting in the way I have described at certain times and under certain circumstances. It is clear that, having no cable to carry in the towing vessel, you can carry plenty of coals, and that the trim will not be subject to the tremendous variation between 1,500 tons and nothing, by way of cargo, and independently of the coal consumption. Here, then, is a reel which carries your cable in water, keeping it cool, which you cannot sink in a gale (for where ships founder casks often float), which does away with all danger to ship and crew, and which, I think you will admit, in any moderate weather, would lay your cable as straight and free from kinks as possible.

I have not yet told you what is, nevertheless, a very important point, that the weight of this cylinder would be about 260 tons, if of ½-inch iron plate, inclusive of two double ends, two partitions, paddle wheels, stays, frame, &c. &c., and that the total cost would be about £4,000, one-sixth of the value of a ship, if built to carry the same quantity of a similar cable.

Diagram No. 2.



A, curves of cable when ship goes faster than cable can sink. A B, increases in length if specific gravity is diminished or speed of ship increased.
C, curve when cylinder is stopped on its way.
D, catenary curve assumed when progress has been stopped long enough to allow cable to reach it.

The electrical communication which it is necessary, or at any rate advisable, to keep up during the towing of the cylinder, and deposition of the cable, is provided for by passing the inner end, in coiling the cable on, out through a pipe, leading from the surface of the cylinder to the axle. Here it is allowed to revolve, freely dipping into a cup of mercury on the frame, or otherwise spring contact may be employed, and from this point a short cable or gutta percha covered wire is led along the towing cable to the ship. If we consider farther the action of the cylinder when towed, we shall see whether the cable is allowed to run off or not, the paddles will cause the cylinder to revolve directly, and in proportion as the ship is towing more ahead. There would be, I have no doubt, a considerable diminution of speed consequent on the towing so large a body while going out to the mid-Atlantic, and therefore not giving off cable. But it need scarcely be feared that the speed of such a vessel as the *Terrible*, which is, perhaps, the best adapted for the purpose, would be diminished to anything like half her usual rate, which is ten knots. Therefore, I believe she would be able to go seven with this astern. A proposition has been made by some naval officers that I should add to the cylinder a false bow of iron, which might be knocked away after getting out to mid-ocean, but I am opposed to this suggestion for two reasons—first, because all unnecessary complexity is to be avoided, the most perfect machine being always the most simple which will fulfil the purpose; and secondly, because if better water lines and easier towing be absolutely required, the best way to get it, in this instance, is by increasing the size of the cylinder, and thereby making it float lighter from the beginning. However, my own impression is decidedly that, if we can do it well enough, we shall do it quick enough. *Sat cito si sat bene*, must be our motto, and if we can accomplish 7 knots, or 168 miles a day, it will, after all, only take five days to reach the mid-Atlantic, the nautical distance being half of 1,650, or 825 miles only. In support of my belief that this speed would be attainable, I may mention that the *Tartarus*, of about 150-horse power, towed the *Caledonia*, three-decker, at 5 knots, her own speed being 8; that the *Napoleon* towed two French line-of-battle ships with a diminution of only 2 knots of her usual speed; and, lastly, that the friction, which it is known offers no inconsiderable part of the resistance to the passage of bodies through water, is here, to a very great extent, absent, owing to the revolution of the cylinder on its axis. Whatever may be, however, the force of the objection to be made as to the towing, it cannot equally apply during the process of laying the cable. Then, not only will the cable aid the advance of the cylinder under certain circumstances, which I have already pointed out, but, with every mile traversed the cylinder throws off a portion of the weight, rises out of the water, and offers a better-shaped bottom for passing through the fluid. But I should deserve the name of a fair-weather seaman if I failed to notice the probable action of a gale, or a heavy sea, on this system of laying. Let us suppose them—first, that a gale is encountered before beginning the laying, while each ship is towing her cylinder to the mid-Atlantic, or elsewhere. As for the cylinder itself, it is absolutely safe under such circumstances, as also the cable upon it, unless the ship, by lubberly management (which I can scarcely suppose to be likely), runs into it, then some damage might possibly occur either to the cable or the frame by which the cylinder is towed. I do not say it would be inevitable that such damage should occur, for I think that in many cases of contact between the ship and cylinder, it would be pushed away without more injury than denting the frame which surrounds it, and which would be made of hollow beams constructed from ½-inch plate iron. But this cause of danger, if it exist, is equally to be found in the system of laying from ships, indeed such a case has already occurred in laying the Toulon and Algiers cable, where, on one occasion, the operation was suddenly stopped by a French steamer, charged to

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convoy her, running into the vessel carrying the cable. I will, once for all, remark that, if, of two systems, the one can be shewn to be safer, more expeditious, and less expensive than another, it cannot fairly be required that there should be no difficulties whatever in it, while that other is full of them. Laying cables across the ocean, whatever may be affirmed by landsmen, can never be other than a most delicate and difficult operation, requiring most scientific seamanship, calling into action all the practical resources of the sailor, combined with whatever aids science can supply. But, to return to the case of a gale occurring, you would lie to, run before it, or keep bow to sea, under short steam, just as circumstances might require. If necessary you might even let go the cylinder, taking care to adopt such precautions as not to lose sight of it, and again make fast when the weather moderated. My own opinion, however, is, that under no conceivable circumstances could such a course become necessary. The second difficulty which may occur, is a gale during the laying. This may declare itself, ahead, astern, or on either beam. If the gale be ahead a diminished rate of progression will be the result, for, if the captain knows his work, he will not attempt a high speed. "Thrashing at it" would do no good, and might do a great deal of harm. But, at any rate, not so much danger need be apprehended as with a ship which has the cable coiled in her hold, for several reasons. First, the pitching and rolling, as you will see by comparison of the diagrams marked fig. 2 and fig 3, are, as well as the send, either totally absent in the cylinder, or very materially modified; the rise and fall of the wave, together with its forward impulse, during the short time it is passing under the cylinder being the measure of motion imparted to the cable, which is always being steadily unrolled or paid out. There is no uncoiling in a hold, or handing out packings or lashings (see "Blue Book"), nor any landsman superintending a brake while he himself is scarce able to stand or see, and very likely devotes one hand to his own purposes and one to the requirements of the cable, if even he is able to do that.

(To be continued.)

NEW ATLANTIC TELEGRAPH.

A few evenings since, Mr. Cyrus W. Field gave a short address on the Atlantic Telegraph before the Geographical Society. He claimed that a cable could now be laid down which would avoid all the difficulties that had been fatal to the first. He said that of more than 6,000 miles of wire, manufactured and laid down by the Messrs. Glass, Elliot & Co., less than one per cent was now in actual operation.* This company was ready to make and lay down a cable at the bare cost of material and labour, taking their pay for interest on capital and for superintendence, in stock, after the cable is tested. The wire which they proposed to make had 510 pounds of copper per mile, to 93 pounds per mile in the old cable. The conductors were better insulated and protected than before. They had 13 strands of 3 wires each coated with gutta percha, while the 18 wires of the exterior protection of the old cable were not coated at all. The new cable had double the strength of the old, and at the same time was lighter in the water, a very important matter, as even if broken, it could be recovered as had been done in the Mediterranean.

Mr. Field alluded to the Behring's Straits route, 18,000 miles to London, and the route by way of Iceland and Greenland. Were all laid, he thought there would be business enough for them all. But it was the opinion of Dr. Hayes that no cable could last near Greenland, on account of the ice grinding the bottom of the sea. The difficulties of length of circuit had been overcome, if they were not disposed of, by the successful working of the first cable. Could the money be raised soon the cable could be manufactured so as to be laid down in the summer of 1863. In answer to a question, Mr. Field stated that the two governments had agreed that neither should interfere with the working of the cable. Last December, the English Government negotiated with manufacturers in regard to a cable, and found that they could have one laid down in July. In case of war the British Government would lay down a cable as soon as possible.

[The non-interference with the telegraph by the two governments, here alluded to, amounts almost to a laughable joke. In time of war England would certainly not interfere with the cable. Having both ends under her control she would encourage its operations as much as possible. The Government of the United States under such circumstances could not possibly get the slightest benefit from it. In case of war between the two nations all civil and business intercourse would cease, and Uncle Sam would be compelled to give up his right to the use of the cable.—Eds.]—*Scientific American.*

* This is an obvious mistake; not one per cent. of the cable laid by Messrs. Glass and Elliott being now *inoperative*.—Ed. E.

The Student.

[Concluded from page 35.]

Magnetising Steel Bars.

The method last described is known as that of Knight, modified by Scoresby. In Dr. Knight's original plan, the needle to be magnetised was placed *under* the opposite poles of the two permanent magnets, the latter being then moved outwards and replaced in their original positions from above. The system of making artificial magnets, without the aid of the loadstone, of course attracted extraordinary attention when first published, after the death of Dr. Knight, by Mr. Wilson. When applied, however, to bars of tolerable size, it was found to be by no means so effective as in the case of small bars. Modifications and improvements upon the process soon followed from further researches, and some of these we will proceed to describe.

It should be mentioned that the property of a needle, "touched" with the loadstone, to place itself in the magnetic meridian was known in Europe prior to the year 1200. The same property, and also the variation of the compass, were known to the Chinese at a very early date, and more fully described in a work written by a Chinese philosopher, about the year 1111. The loadstone is an ore of iron, containing both the protoxide and the sesquioxide of the metal. It may be formed artificially by exposing fine iron wire at a red heat to the action of steam. It then forms minute octohedra, which are highly magnetic.

The method of Duhamel, a modification of Knight's original process, is as follows:—Instead of simple bar magnets, two compound magnets, formed by uniting several magnets with their similar poles together, are usually employed. Two steel bars to be magnetized are placed parallel to each other at a small distance apart. Their ends are then united by two small pieces of soft iron as armatures, without which the magnetic power communicated is comparatively small. The opposite poles of the two compound magnets are placed upon the central portion of one of the bars; the magnets being, however, not held horizontally, as in Knight's process, but at an angle of about 45° to the steel bar, so that the opposite poles of the magnets, which are not in contact with the bar, are at a distance from each other. By this means the two magnets do not exert a neutralizing action upon each other. The magnets are then moved in opposite directions to the extremities of the bars, and beyond this point, until they are at arms' length, as in Knight's process; and, the poles being reversed, they are now applied to the second bar in the same manner. The "passes" are applied alternately to each bar, some ten or twelve times, care being taken to preserve in each case the original disposition of the poles. The bars should then be turned over, and the process repeated on the other side.

Duhamel's process was somewhat improved by Epinus, who substituted two short permanent magnets for the armatures of soft iron uniting the extremities of the bars. The north poles of these armature magnets should be in contact with the extremities of the bars which are intended to become south poles, and *vice versâ.* In every case the north pole of a magnet induces south polarity in that portion of a steel bar which it traverses. This must particularly be borne in mind in the application of Duhamel's process.

The methods we have now to advert to depend upon a different principle. In the processes we have described, that portion of a steel bar which assumes north polarity is always under the inductive influence of the south pole of a magnet. But the two opposite poles may be moved together over the whole length of the bar of steel in such manner that each portion of the bar is successively under the influence both of the north and of the south pole. Or a coil of wire conducting a voltaic current, may magnetize successively every portion of a steel bar, so that any point of the same becomes necessarily endowed at different times with the opposite polarities; and, providing the opposite polarities induced at any moment, always preserve the same relative position to each other in the bar, a permanent magnetic effect will be produced, the particles of the steel arranging themselves so as to assume the magnetic polarity in one determinate direction. Mitchell's "method of double touch" is as follows:—

Five or more steel bars laid end to end in the same straight line, and two compound magnets are placed vertically, with their opposite poles upon the middle bar, these poles being only about ¼-inch apart. The magnets are then moved together backwards and forwards throughout the whole length of the line of bars. The bars are then turned so that the operation may be repeated on both sides, or, with a square bar magnet, on the four sides. It will now be found that the middle bars are more strongly magnetized than those placed at the extremities of the line, but by placing the latter in the middle of the

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series, and repeating the operation, they will acquire the same power as the rest.

The following will, in many cases, be found the easiest and most convenient method of making a permanent magnet. It is known that if a steel bar or horse-shoe is coiled as an electro-magnet, and a powerful current is transmitted through the wire, permanent magnetism will be produced. But, adopting the principle of Mitchell's "double touch" system, we may magnetize a small portion of the bar at a time, and the whole influence of the current being exerted at this particular point, it becomes possible, with the same battery, to produce a much higher degree of magnetism. For this purpose we require a length of wire wound so as to form a hollow cylinder, very short, but as thick as may be convenient, and of an internal diameter sufficient to contain the bar to be magnetized. The wire of which it is composed may be, as in the case of electro-magnets, either of large or of small diameter; but, if constructed of fine wire, a very considerable length will be required, and sufficient tension must be obtained in the battery to overcome the resistance. With a stout wire, a quantity current is required, and may be best obtained with a few cells of the cast-iron battery. The galvanometer should be employed to ascertain the best arrangement of a given number of cells for transmitting the greatest quantity of electricity through the coil. An armature of soft iron being applied to each end of the bar to be magnetized, the latter is to be inserted into the coil so that this may surround the middle of the bar. The battery connection may then be made, and the coil, as when a magnet is used in the method of double touch, is to be moved up and down to the extremities of the bar. When several "passes" have been made, the coil is brought to rest at the central portion of the bar, and the battery circuit is broken. Generally speaking, the harder the steel the more difficult it is to produce a magnetic effect, but in every case a current of very considerable magnitude should be employed; the battery being increased either for "quantity" or "tension," according to the resistance of the coil employed, until the desired magnetic effect is obtained, magnetism of horse-shoe bars.

Steel bars of horse-shoe shape may readily be magnetized by the method last described. An armature of soft iron should be applied to the extremities, and the cylinder of wire should be so constructed as to be moved readily upon the magnet from one pole to the other. Battery contact should be made and broken when the coil is at the bend of the horse-shoe. If magnetized by Duhamel's method, the two magnets should be placed with their opposite poles at the bend of the horse-shoe and moved to, and beyond, the extremities. Or according to Mitchell's system, modified by Epinus, a short bar magnet, or a horse-shoe magnet, may be used as an armature, and the contrary poles of two magnets, or the poles of a horse-shoe magnet, are to be applied at the bend of the steel bar and carried round and round over the horse-shoe and armature, but always in the same direction as will now be understood.

PRICES CURRENT OF INSULATING MATERIALS.

GUTTA PERCHA.

A parcel of the low ordinary reboiled (old imports) has been sold at 10d. per lb. warrant weights.

INDIA RUBBER.

Fine Para	2s. 0d. to 2s. 1d. per lb.
Negro Head	1s. 1d. to 1s. 4d. „
Java	1s. 5d. „

May 29, 1862. WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

Telegraphic News.

THE ATLANTIC TELEGRAPH COMPANY.

WE believe that Her Majesty's Government has expressed to the Chairman and Directors of the Atlantic Telegraph Company its willingness to grant the use of vessels for the purpose of making further surveys of Trinity Bay, and also of portions of the Atlantic Ocean near Valentia.

Application has also been made, with every probability of success, for vessels to aid in laying the cable between Ireland and America. This is a step in the right direction.

UNITED KINGDOM TELEGRAPH.

ON the motion that the Bill of the United Kingdom Telegraph be read a second time in order that it should be referred to a committee,

Mr. HUMBERSTONE moved as an amendment that the second reading be postponed for a week, in order that the House should have time to consider whether a Bill of this kind should be treated as a private Bill at all. He complained that the measure was one which seriously affected the public rights, and would cause material inconvenience by setting up posts on the highways of the kingdom; and that further notice of its nature ought to be given to members before they were asked to read it a second time.

Mr. HENLEY objected to going on with this Bill before further information in respect to its character had been obtained. These posts and wires were already set up in various parts, and had been declared by legal tribunals to be a public nuisance. He believed that in some parts serious accidents had arisen in consequence of the posts and wires having been blown down; and he called attention to the injustice that would be done to poor people in consequence of having the posts and wires set up before their doors, and who would, practically, be prevented from appealing, because the appeal was to the Board of Trade, of which they would know nothing.

Sir F. SMITH supported the second reading of the bill on the ground that it was the only measure that would destroy the existing monopoly enjoyed by the electric and magnetic companies.

Lord A. CHURCHILL said that ample provision had been inserted in the Bill for the protection of the landowners. It was greatly for the interest of commerce that such a Bill should pass, and he did not think it would be either fair or just, after the company had succeeded in passing their Bill—in the face of tremendous opposition—through the House of Lords, that it should now be defeated by a sidewind like this in the House of Commons.

Mr. M. GIBSON considered that the proper tribunal to deal with the merits of the scheme was the usual committee of the house, and therefore that it ought to be permitted to be read a second time.

Sir J. SHELLEY thought that the question of electric telegraph communication ought to be dealt with in a public Bill.

Lord HOTHAM supported the amendment.

Mr. HODGSON expressed great surprise that a member of the standing orders committee should get up and propose that such a course as that suggested should be taken in reference to a Bill which had fulfilled all the conditions required by the standing orders.

The amendment was then withdrawn, and the Bill read a second time.

ELECTRIC TELEGRAPHS.

LORD REDESDALE, in presenting certain petitions praying for some uniform measure to be introduced for the regulation of electric and other telegraph companies, said that no doubt the powers that these companies had obtained had, in many cases, been much abused, and to such an extent in some cases had this gone, that it was quite necessary that something in the way of general legislation should be done with regard to it. The petitions he had to present were from various landowners, and the trustees of turnpike roads. Those petitions pointed out certain grievances, and the manner in which private property had been affected by these companies. In the parish of Kingshorton a footpath was being made for the accomodation of the district, and a line of telegraph posts had been laid down the centre of this path, by which the intended improvement had been destroyed. In the parish of Yardley the telegraph poles had been placed only eight feet from the centre of the road, He thought the matter could not be too early taken in hand, and it was with this view that he presented these petitions.

Lord HATHERTON thought that a general measure should be introduced in order to make the law uniform on this subject.

Lord STANLEY of ALDERLEY said that hitherto the companies had been satisfied with laying their lines along railways and canals, but recently powers had been taken by private Acts of carrying the lines along public roads, and in some cases across private property. He himself had received petitions of the same nature as those presented by the noble lord, complaining that property, especially in the neighbourhood of towns, had been deteriorated by these lines of telegraph. The powers under the Bills of these telegraph companies were very varied, and some of the powers went so far as to enable the companies to enter private property without the consent of the owners. He agreed with the noble lord that it was desirable that there should be a general measure on the subject, by which some uniform principle should be laid down with regard to the power of these companies.

After a few words from Lord REDESDALE in reply,

The subject dropped.

MALTA AND ALEXANDRIA CABLE.

THE screw steam gun boat *Growler* left on the 15th for Tripoli and Bengazi, under the command of Lieut. Curtis, of the *Hibernia*, carrying Messrs. Gibson and Preece to inspect the telegraph cables, and wires, at those stations.

WITH further reference to the advantages gained by persons who are in a position to secure the receipt of early intelligence from America in advance of the general public, it is stated that the subject has for some time past attracted much notice in Liverpool, where at this crisis of the civil war any news of importance creates great fluctuations in the price of cotton, and much distrust is caused by the belief that the market is largely

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operated upon to the serious disadvantage of the general mercantile public. It is said that a system now exists, the working of which may to a certain extent explain how priority of information is obtained. When the homeward mail steamers from America pass Roche's Point, a tin case, or small barrel, containing the messages for certain favoured persons, is thrown overboard and picked up by a boat on the look out. The contents of the dispatches are then telegraphed from Roche's Point station, whilst the large number of telegrams, addressed to merchants, &c., are taken on to Queenstown, and the information they contain is of course anticipated by those messages previously transmitted. If this statement proves correct, it would appear that the present system is objectionable, and calls for the serious consideration of those most deeply interested.

AT the Court of Bankruptcy, the petition for winding up the United Kingdom Electric Telegraph Company (Limited), was dismissed, the alleged debt having been paid "under protest."

TELEGRAPHIC PROGRESS.

A SUBMARINE cable is now being manufactured for the Indian Government, to be laid, we believe, across the Persian Gulf. The cable is being manufactured by Messrs. Hall and Wells, of the Telegraph Works, Borough Road, Southwark, according to their patent process; the copper conductor is first covered with pure virgin india rubber, then with masticated rubber, and a serving of hemp with a shield of spirally wound iron wire. We believe this latter process a mistake; we should have preferred the longitudinal steel wires protected from rust in tarred and platted hemp. Messrs. Hall and Wells have supplied some miles of their india rubber covered wires for Her Majesty's Government for experimental test at Shoeburyness. This recognition on the part of Her Majesty's Government of the applicability of india rubber for submarine and subterranean telegraphic purposes, augurs well for the future employment of this material as an insulator.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

SIR,—The short article by "Aled," in THE ELECTRICIAN of May 9th, has puzzled a small circle of my friends (and your readers) exceedingly; without any explanatory remarks, permit me to draw up the curtain on our last meeting.

With spectacles astride the nasal promontory, our venerable friend Truffles is absorbed with the problem (the article above-named), he has just read it for the sixth time, and exclaims, "What can it mean?" Peewit explains (P. is our electric and telegraphic interpreter general and referee) that a wire is generally overcharged with electricity, and being unable to carry the whole charge at once, the surplus flies off through the insulator, thus relieving the wire and facilitating the transmission of the residue, "But whether by leakage or by induction," quoth Peewit, "doth not appear." Jones is dissatisfied with the explanation, considers P. has mystified the matter utterly, and is, therefore, no longer to be regarded as our scientific mentor, the cause *does* appear, he (Jones) considers it evidently means induction, for, although the word "faulty" occurs, it is not likely, if any other description of fault existed that they (the electricians) would acknowledge it. Truffles dissents from his friend Jones; "induction is not be considered a fault, since, except in theory, there is no such thing as a perfect insulator, whereas a leaky place would be a fault; but sure-ly," continued Truffles, "no electrician would argue in favour of a leaky wire under any circumstances." Timkins observes that "he can see no difference between leakage and what is called induction; to distinguish them is like explaining the difference between six and half-a-dozen." At this juncture, the present writer, while deploring "Aled's" ambiguity, thinks T., J., T., and P. will not mend matters by muddling them, proposes having recourse to the fountain-head, *i.e.*, the Government Report, explains from that interesting volume, that the insulated coating of a telegraph wire absorbs part of the charge, that this absorption (not to be mistaken for a porous absorption) is called "induction,"—that this induction retards the rapid transmission of signals in proportion to its amount, as the wire must be cleared before a second signal can be made; that induction is, therefore, an evil; that this evil is considerably mitigated, and the rapid transmission of messages and telling off of signals effected, if the insulator be just sufficiently leaky to let off the fluid thus absorbed; that this leakage may be caused by a fault, or defective insulation, for instance, an infinitissimal aperture just sufficient for the escape of so subtle a fluid as electricity, and yet too minute to admit of any external element which might do injury, or from the conducting wire becoming eccentric, that is, want of centricity in certain places, where it will necessarily have but a very thin coating on one side—a mere film, which, of course will constitute a fault, and a rather serious one too; that, in short, leakage is a natural result of bad workmanship, whereas induction is a natural consequence of using a material as an insulator, which is itself, although only to a small extent, a conductor. I close the Blue Book; the conclave nod in concert, which flatters me; but Timkins, who has been asleep all the time, still persists that there is no difference between six and half-a-dozen, and, therefore, none between leakage and induction.

Now have the goodness to imagine the curtain descended, and myself addressing you in the usual way, on this subject broached by "Aled."

We have, as we have seen the highest authority in support of the fact, that a small amount of leakage in an insulated wire, whose rate of inductive capacity is high, is advantageous in ridding the dielectric of the electricity thus absorbed when the wire is charged, thereby increasing the rapidity of signalling; and, indeed, this seems so reasonable and self-evident that it would be idle waste of time to dispute it.

The point at issue is, can this rapidity in the transmission of messages by the above means be with safety resorted to? The common experience of every-day life, as applied to analogous cases, gives a decided negative. No matter how imperceptibly small the aperture in your water-pipe, nor how insignificant the defect in the join of your gas-pipe, they will not mend themselves if left alone, they cannot remain stationary just what they are; there is but one alternative, they must get worse. Assuming, for argument sake, that you secured a more brilliant light because of the defective join, and a more copious supply of water because of the existence of the aperture, you would, notwithstanding, deem it the truest wisdom and economy to forego the one and eschew the other, and have your domestic conductors forthwith repaired. And you will probably remember, intelligent reader, when in getting off the 'bus in Piccadilly you caught your best West of England on some intolerable protuberance (which, may confusion seize), you found the small rent, although useful in admitting a little extra cool air on that sultry day in July, was a decided disadvantage in every other respect. And why should an insulated telegraph conductor be an exception to the universal rule, if a fault exist it must of necessity become worse; there is no such thing in creation as a state of complete quiescence, or what in a telegraph wire, as applied to a fault would be termed a "remaining constant." When forms, instinct with life, suffer any mutilation short of the loss of any integral or vital part, Nature at once combines the necessary restorative elements, and hastens to replace the loss by a new creation; not so with dead, inert matter; if a cable be faulty a hundred fathoms under water, it is possessed of no inherent power of self-restoration; it cannot remain constant, and, therefore, speedily becomes useless. The circumstances which appear to favour an opposite opinion, as referred to by Mr. Siemens at page 10 of the Government Report, serve only as additional proofs of this postulate. The matter stands thus: a long line of submarine cable, in order to be successful as a commercial undertaking must be made capable of being worked through at a certain number of words in a given time; at the same time it is important that it should be durable, sufficiently so, indeed, to enable the company, or proprietors, to realize their own capital with a moderate per centage of profit. Now, if a cable be submerged through which can be transmitted only half the number of words requisite to make it a successful speculation, and recourse be had to producing a fault, or faults, which shall have the effect of doubling the speed of transmission, and that desideratum is arrived at by thus involving the gradual and premature destruction of the core, and so putting the proprietors to the expense of a new one, when only a moiety of their capital has been refunded, is something like, on the one hand, Scylla, on the on the other, Charybdis.

Fortunately, there is a remedy for all this, and but one—an improved insulator—gutta percha has a high inductive capacity, and conductors insulated therewith have much to contend with in the shape of retardation; the electricians whose observations have led to the discovery of the state of things now under consideration, had none but gutta percha insulated wires and its compounds whereon to ground the assertion therein contained, and which must be accepted only so far as it applies to the material above-named.

But prejudiced electricians scratch their heads over this difficulty, as though it were an abstruse problem they had to solve, and to get over it they suggest this, that, and the other fine thing, and like old-fashioned allopathists, would even create a new disease in order to expel the old one, instead of adopting the rational remedy within their reach.

Insulation by means of caoutchouc properly applied (and this "properly applied" comprehends more than people are aware of) is an effectual remedy. It is said there is no such thing as a perfect insulator, no material which can be used for that purpose that will admit of no induction, and, therefore, the evil remains, although in a less degree; but this is merely splitting straws; by the same rule we may say there is no such thing as a perfect vacuum, nevertheless, it is possible to get one perfect enough to answer every purpose. It is not perfection we seek after, but proficiency, or like Diogenes we might light our lantern and seek it in vain, whether morally, physically, or materially.

India rubber supplies the desideratum, it is a perfect, or more properly, a proficient insulator; its inductive capacity is practically nil, if the right stuff is applied, in the right way, and by the right men. Bring this material into use for submarine cables and you will have no occasion for having recourse to an anomalous and suicidal means of securing rapidity of transmission.

MOMUS.

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The Electrician.

VOL. II. No. 31.—JUNE 6, 1862.

CONTENTS:

	PAGE		PAGE
Steps to Theory by the Practice of Electricity	49	The Patent Laws	56
Absorption of Water by Caoutchouc	50	Proceedings of Societies	56
Some Considerations on the Principles of Electrical Conduction and Accumulation	51	Electric Animals	59
Bonelli's Telegraphic Apparatus at the International Exhibition	53	Prices Current of Insulating Materials	59
On the use of Cylinders in laying Submarine Telegraphic Cables	54	Telegraph Shares	59
		The Atlantic Survey	59
		Telegraphic News	59
		Correspondence	60
		Miscellanea	60
		To Correspondents	60

STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 39.]

Electro Telegraphy.

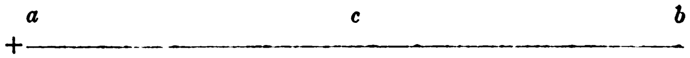
239. IT is probable our readers will have noticed in this essay that we have not made use of a variety of technical terms; our object has been to restrict ourselves to the smallest number compatible with a clear exposition of our subject, selecting those which convey in the most palpable manner each a specific meaning. Amongst others that we have omitted as inappropriate or unnecessary is the word tension, and in now drawing to the circumstance the notice of the telegraphist, to whom the term is so familiar, we have to beg, that as in the past, so in the future, the older expression intensity may be read as meaning, whenever it shall occur, energy of electrical force, in contradistinction to quantity of electrical force—a distinction which is lost in the general expression tension, and whence has arisen our desire to exclude the latter from these pages, which we are endeavouring to keep free from ambiguity. It has been by others argued in favour of its exclusive adoption, to the entire abandonment of intensity, that this our term is in frequent use on the continent to imply a wrong meaning; but then tension is generally used by English telegraphists to convey an idea of *quantity of force*,—not energy merely, nor quantity merely, of electricity, but both together,—as we shall presently understand. If we had to reject either term for its greater abuse we might perhaps be sorely puzzled to choose between the two; each has its own popular signification, as pointed out in a contribution to be found in THE ELECTRICIAN, Vol. I. p. 274, and the one we have had occasion to use we have taken care to limit to that signification, as we shall also do in the case of the other if we find any necessity to introduce it.

240. It may be well, once for all, by an example, to put the word *intensity* in what we regard as its proper relation to its correllative term quantity. Let fifty particles of electricity be a plus charge acting by induction upon fifty particles of common matter; if the intensity of attraction of equal numbers of both kinds of particles be called unity, then unity will express the intensity for any portion or the whole of the particles attracting one another, although the quantity of attraction, or force, in effective exercise between them will be fifty units. But if a plus charge of a hundred particles of electricity be acting inductively on the fifty of common matter, the intensity of the electrical force for either part or the whole will be four units instead of one as before, as is required by the electrical law of quantity, for $100 \div 50 = 2$, and $2 \times 2 = 4$; while the quantity of electrical force in action will be $50 \times 4 = 200$. We call the charge quantity of electricity; its action on any given unit of common matter intensity of force; and its total action, or the quantity multiplied into the intensity, quantity of force—electricity and its force being different things, the latter varying as the square of the former (par. 39 *et seq.*).

241. It will be admitted by all electricians that the quantity of electricity which any cell of voltaic elements is competent to furnish in an unit of time, increases in some ratio with the dimensions of their active parts; and also, the dimensions of the elements being given, that the intensities of electrical charge emanating from them increase in some ratio with their number acting in series. We need not just now trouble ourselves to define the ratios more minutely; merely remarking that as we increase either the number or the size of our voltaic elements, so we make them competent to furnish in a given time increased quantities of force; and with those increased quantities of force increased quantities of electricity also, because, by the electrical law of quantity, intensities imply the presence of quantities varying as their square roots. Supposing, therefore, the means of egress to be out of question, or to be fully adequate to all exigencies, the quantities of electricity furnished by a voltaic battery will increase in some ratio as its elements are made more numerous in series, as well as when they are constructed of larger dimensions.

242. In our last we gave the laws of conduction as they flow from our doctrines; we have now to consider those laws in relation to charges found in practice upon the surfaces of wires used in telegraphs.

Fig. 35.



Let *a c b* in the preceding figure represent an insulated wire of given nature and diameter, any number of miles long, stretched in the atmosphere, *c* being the middle of its length; and let the sign + be a never-failing source of electricity of uniform intensity, to be occasionally put into communication with the extremity of the wire *a*.

243. The extremity *b* being insulated, and *a* in connection with the + source, electricity will suffuse itself over the whole length of the wire, attaching itself to the common particles on its surface in just that quantity which will raise its intensity to an equality with that of the + source; because, first, plus electricity can attach itself to any of the common particles of neutral conductors for the shortening of its normal field of attraction (par. 217), and because, secondly, the whole length of the wire possesses, by virtue of the surrounding atmosphere a charging capacity for receiving it under an intensity of inductive action and reaction inferior to those in exercise at the + source, (par. 71 *et seq.*).

244. The quantity of charge required for occupying different wires, *a c b*, the intensity and all other conditions being uniform, will vary in the simple ratio of their lengths; because the charging capacities are conferred upon the wires as the axes of cylinders of inductive atmosphere, or other insulating matters, that increase in length as the wires themselves increase.

245. Time will be occupied by this acquisition of charge because charge must be preceded by the motion preliminary to both the suffusive and the true conduction, and motion is opposed by inertia.

246. In wires, *a c b*, of different lengths, the periods occupied by the true conduction will, by the second law of conduction, vary as the squares of the lengths of the wires, or which is the same thing, as the squares of the lengths *a c;* because the units of charge, truly conducted, will enter the wire consecutively, each experiencing inertia at every unit of length it passes through, and those units of length will be in number for the mean of all the units of charge as the half lengths of the wires respectively.

247. The same law applies also to the suffusive conduction along the surfaces of the wires; because the electricity so conducted is in quantity proportionate to their several lengths, and every unit of that quantity is subject to inertia in passing through each unit of the lengths.

248. If the extremity, *b*, of the wire be connected with the earth, and the + source supply electricity to the contiguous end

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of the wire at a quicker rate than it is being removed from the further end, the quantity of charge suffused over the surface of the wire will be greatest at the extremity nearer the source, declining to nothing at the farther extremity; because at the former place the quantity may be any not exceeding what is great enough to exert an intensity equal to that of the + source, while that at the distant end cannot be so great as to exceed in intensity that which is infinitely small at the receiving charging capacity.

249. Reducing the diameter of a given wire, *a c b*, will lessen the quantity of electricity it can receive as a charge from the + source under any given intensity; because its charging capacity under a given intensity varies with the surface of the surrounding inductive atmosphere or other material, measured at any given distance from its surface, and the surface so measured is less as the wire is smaller (par. 80). But a given reduction in the diameter of the wire will not reduce the charging capacity equally for any two different intensities (par. 105, *et seq.*).

250. Let *a c b*, of given dimensions, be charged by connection with the + source, the extremity, *b*, of the wire being insulated. If the end, *a*, be put to earth, the charge will return upon its course from *b* to *a*, and pass into the earth; because when there the plus electricity will be opposed by a lower intensity of inductive reaction than before. The quantities of electricity so returning will vary as the square roots of the intensities of the charges, because the intensities, by the electrical law of quantity, vary as the squares of the quantities; or the intensities being given, simply with the charging capacities of the wire, which when conferred by induction on the atmosphere around a naked wire, will be a minimum.

251. The duration of the return charge (par. 250), will, under simple atmospheric induction, be a minimum; because as that atmosphere had only ceased to attract, without actually parting with the natural electricity of which it was virtually dispossessed by the induction (par. 87), its recovery of it needs no new motion of electricity to be originated, and therefore is not delayed by inertia.

252. If the extremity, *b*, as well as *a* (par. 250), be uninsulated at the same instant, the current will be divided in the middle of the wire at *c*, and half the plus electricity be discharged in either direction.

253. The same will be true of the return currents (par. 250, 251), if the extremity, *b*, of the wire *a c b* be from the first uninsulated, provided the + source supply electricity in sufficient quantity for the surplus, over and above that which is conducted away, to form the charge of the wire.

254. The + source being given, and electricity passing from it at a given speed through the wire *a c b* into something at the further end having an unlimited charging capacity of infinitely small plus intensity; halve the length of the wire by dividing it at *c*, and put both ends of the divided wire to earth. By the 3rd law of conduction we thereby halve the inertia, and consequently double the speed along every part of the wire remaining in communication with the + source. Then to the further end of the second half of the wire *c b*, connect a source of minus charge equal in every respect to the + source by which the first half is charged. The second half of the wire will then have electricity passing through it with exactly the same speed as the other half; now insulate the two inner ends of the divided wire and connect them together at *c*. It is quite obvious that thereupon no alteration in the rate of the speed will ensue, from which it follows, that by using two similar voltaic combinations for a telegraph wire of given nature, diameter, and length, one having its plus pole in connection with one of its extremities, and the other its minus pole in communication with the other extremity, the free poles of both the sources being put to earth, we shall have along the wire a double speed, and consequently, in a given time, a double quantity of electricity in effective motion.

255. Another advantage to be derived from the employment of a plus source at one extremity of a telegraphic wire, at the same time that a minus source is connected with the other, is in the conversion thereby, to some larger or lesser extent, of the suffusive into the true conduction; by furnishing, in place of the earth in its normal condition, a minus receptacle for the plus electricity it has less need of the artificial equilibrium to be obtained by acting inductively from the surface of the conductor.

256. Our view of electrical action applied to the organization of the electric telegraph discredits the practical agency of the earth as a conductor for completing the voltaic circuit; the theory intimates that when the opposite poles of a voltaic arrangement are put to earth at spots widely separated, no circuit is necessary, the service demanded of the earth being simply that it should receive into, and deliver from, its practically boundless capacity for electrical charges, either minus or plus, at an infinitely small intensity of inductive reaction, whatever quantities of electricity may be presented to, or demanded from it; our voltaic combinations being only means for extracting from it at one pole, and rendering up to it at the other in a given period of time, quantities of electricity under intensities of electrical attraction, for which the apparatus has been adapted by its construction.

257. This, of course, is speaking of the earth as a large conductor, placed in the centre of an insulating atmosphere upon which any electrical charge that it possessed could act inductively; setting up, by its means and under the most favourable circumstances, the artificial electrical equilibrium which we are so constantly referring to as one of the most important features of our theory. And in reality the earth is always in a state of electrical charge; for although it be not so as a whole in consequence of anything we can do to it, there are both plus and minus vapours floating above its surface that must make it so in parts by reason of induction, consequent upon definite electrical attraction. The phenomena known as earth currents, which occasionally disturb the regularity of the arrival of electro-telegraphic signals, thus find their origin; for over the end of a telegraph wire put to earth there may suddenly occur an electrical induction superior in intensity to that of the charge at the voltaic source in communication with it; and wherever that happens to be the case a natural current may for a time supersede the passage of the artificial current altogether. In naked, or aërial wires, this interference may be overruled generally by making a permissible increase of intensity in the voltaic action; but when the wire is surrounded by insulating materials which would thereby be put in jeopardy, in consequence of the perforating propensities of intense charge, it becomes a serious question whether a portion of time had better be sacrificed by a cessation of the manipulation, or the telegraph lost altogether.

258. These being the main principles that are involved in the performance of the electric telegraph, we shall in our next issue extend their application from the aërial line, which as the most simple we have considered first, to the submerged cable; and in doing so we shall theoretically pass through some of its intermediate conditions.

(*To be continued.*)

ABSORPTION OF WATER BY CAOUTCHOUC.

A considerable portion of the paper by Mr. C. W. Siemens, lately read at the Institution of Civil Engineers, and given (p. 56) in our impression of this week, is devoted to a process for insulating wires with india rubber (masticated), covered externally with gutta percha. Some importance appears latterly to have been attached to this method of insulation; and the grounds upon which advantages are claimed for the same are worthy of some examination. It is known that the insulating materials which have hitherto been used increase in weight to some extent when immersed in water, owing to the absorption of fluid.. From the experiments made under the auspices of the Govern-

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ment Telegraph Committee, it appears that the absorption by gutta percha in sea water is almost *nil*, while the absorption by india rubber is always sensible, "the surface being rendered white and opaque, owing to the amount of water that has penetrated into the substance." It was at one time feared that this surface absorption might gradually increase under continued immersion, until the insulation of caoutchouc-covered wires would become impaired or destroyed. The experiments made to determine this point led, however, to a different conclusion in regard to masticated rubber; the result of these experiments being summed up in the Report as follows:—"The absorption reaches only to a small depth, and does not destroy or in any way impair the insulating power of that portion of the caoutchouc which is immediately beneath the moistened layer." Moreover, the following data are given as results of the experiments of Messrs. Siemens:—"The thickness of the sheets of material employed affects the absorption in a much higher ratio than can be accounted for by the simple increase of surface. The absorption of water by the thicker sheets appears to *stop short* at a limit which is rapidly exceeded by the thin sheets. *The conductivity of these materials appears not to be materially affected by the absorption of two or three per cent. of water, which may be taken as a limit that will not be exceeded in sea water and at ordinary temperatures.*"

We are not aware that any further experiments have been made disproving these results. It is difficult, therefore, to arrive at the appreciation of any advantage which would follow from the process referred to by Mr. C. W. Siemens. A very thin coating of gutta percha might, according to evidence adduced in the portion of the Report from which we have quoted, become permeated by water, in which case absorption by the caoutchouc would take place. A thicker coating would probably not be equally efficacious with an equal thickness of masticated caoutchouc. But there is some evidence, which may be forthcoming on the part of those who have already tested the combination of caoutchouc with gutta percha as an outer covering, that much more serious disadvantage results to the enclosed insulating material than at first sight would appear probable.

But we have to give our attention to some of the statements contained in the paper of Mr. Siemens, and bearing upon the present subject matter. Of these perhaps the most reasonable is that the gutta percha applied in a plastic state by a die process might give greater security against faults than the lapped india rubber covering. But this presupposes that "faults" in india rubber covered wire are occasionally due to the want of adhesion in the portions of the material which are brought into contact in applying the layers, and we have no evidence that at the present moment this supposition is tenable. Again, it is stated that the fact of the gutta percha shrinking upon the caoutchouc is a circumstance greatly in favour of the bi-covered wire. In most samples of india rubber covered wire, the same advantage would result from the compression of the external layers applied under tension, so as to give to the covering a considerable degree of hardness. Any mechanical injury to the outer coating would thus "cause the yielding india rubber to be forced into the gap by elastic pressure."

The following statement, however, if admitted to be correct, would be conclusive as to the expediency of the process adopted by Mr. Siemens:—"Notwithstanding the comparatively high insulating property of india rubber, its low inductive capacity, and its power to resist heat, its gradual dissolution in sea water is a circumstance which alone renders it inadmissible for submarine wires, unless securely enclosed in another waterproof medium."

The "gradual dissolution of india rubber" in sea water is a new fact certainly necessitating the adoption of new means to avoid such a contingency. Most of our readers will probably be inclined with us to doubt this fact until it is substantiated on some grounds of experiment. As in the case of many other improved arrangements and appliances, the method we have referred to owes its plausibility to facts which in the present state of our knowledge cannot be certain of universal acceptance. In the meantime we must remain satisfied with the conclusion arrived at in the Government Report, "that the absorption of water is not to be feared as a cause of deterioration in submarine cables."

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 41.]

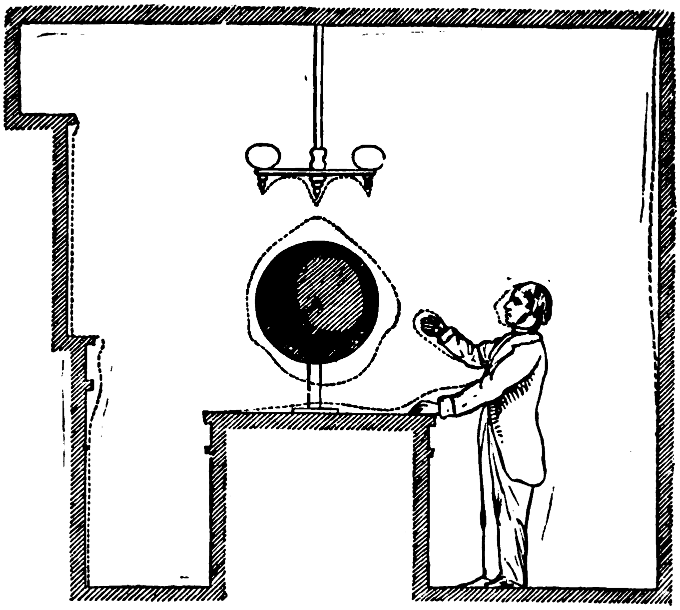
Mathematicians have investigated the distribution of electricity on regular solids on several different theories, as to the action of the particles of electricity on one another, and on the particles of common matter, and it is said that the results arrived at by Poisson, for the distribution of electricity on different geometrical bodies, such as a sphere, ellipsoid, &c., will bear the test of experiment.

It is, however, evident that, unless the form of the outer conducting surface is specified and taken into account in the calculations, no formula based on the mere form of the conductor itself can be rigidly correct; for the distribution must depend also on the form of the surrounding objects on which an equal and opposite charge must exist, and any alteration in the position of these will, of itself, alter the distribution, whilst in practice the outline of the objects forming the outer conducting surface is almost sure to be irregular.

Thus, when a conductor of regular form, such as a sphere, is charged under any other conditions than when placed concentrically within another spherical surface, the distribution cannot be rigidly uniform, however near it may practically approach to uniformity.

In the case of a sphere placed in a room for instance, where the surrounding surface is never spherical, the distribution will be more or less irregular, according as the walls, ceiling, furniture, and persons in it form a more or less irregular outline, as illustrated in Figure 64, the dotted line round the

Fig. 64.



sphere representing the probable distribution on the sphere A. For similar reasons the distribution on a sphere placed in the open air cannot be theoretically uniform, but must have its greatest density on those parts nearest to the surrounding conductors. Thus, even if placed simply above an extended plane, the density would be greatest on the lower part of the sphere.

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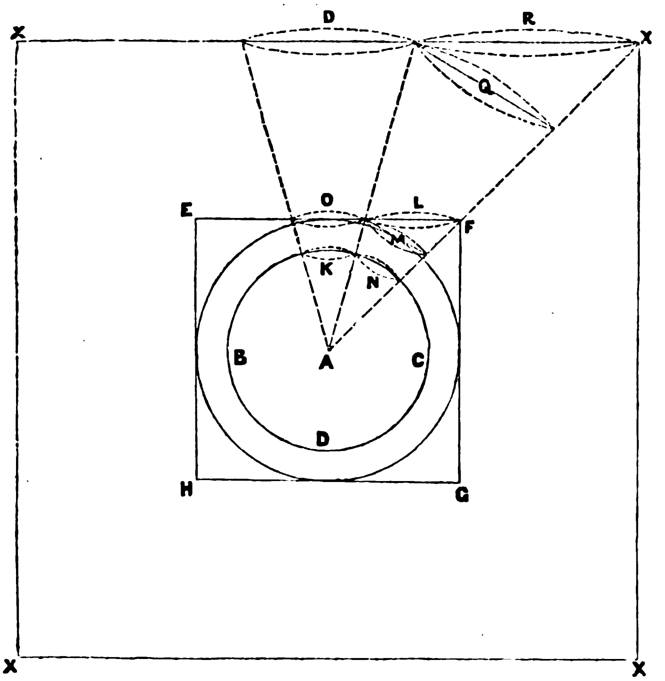
In any attempt at a precise theoretical calculation of the density on any figure, it is evident the outer opposing surface must therefore enter as an element into the calculation, and that any mathematical investigation attempting to solve the problem of distribution without the position of the surrounding surface entering as an element into the problem must be based on erroneous views of the nature of electrical action. Yet in none of the problems relating to the distribution on different bodies, as given by Messrs. Lardner and Walker as the result of Poisson's investigations, does the outer opposing surface enter as an element into the problems.

It is true that, as has been shown, when the outer surface is removed beyond a certain distance from the conductor, any further increase will increase the inductive resistance but little, there will, consequently be some distance when an increase or decrease of distance at any one part only of the outer surface will produce such a slight difference in the resistance in that particular direction between the two surfaces, that practically no perceptible difference in the distribution will occur.

Thus in the case of a sphere surrounded concentrically by another spherical conducting surface, however distant the latter be from the former, equal distribution will result; but if this outer spherical surface, being only a fraction of a diameter greater than the interior sphere, be altered to a cubic surface (having its dimensions equal to the diameter of the spherical surface) unequal distribution on the interior sphere will result. If, however, the outer spherical surface, having a diameter some twenty or thirty times greater than the interior sphere, be altered to a cubic surface, having its dimensions of the same length as the diameter of the outer spherical surface, very little alteration in the distribution on the sphere will result from that which existed when the outer surface was spherical.

The reason of this may be roughly demonstrated if we suppose the different portions of the dielectric resolved into distinct resistances, consisting of the frustrums of similar cones cut off between the two opposing surfaces. Thus let B C D (fig. 65), be a sphere,

Fig. 65.



and let E F G H be a cubic surface surrounding it; then the inductive resistance between a circular portion, K, of the sphere, and a circular portion, O, of the flat surface E F, intercepted by the extension of the same cone having its apex at A, will consist of the frustrum K O; and the inductive resistance between an equal portion, N, of the sphere, and an elliptical portion, L, of the flat surface cut off by the extension of a similar cone, will consist of a frustrum N M (equal to K O) + the oblique frustrum M L. The difference of the two resistances consists therefore of whatever resistance is offered by M L.

If now the cubic surface be extended to X X X X, the resistances separating the same portions, K and N of the sphere, from the outer surface, will consist respectively of the frustrums K D, and N Q (=K D) + the oblique frustrum Q R. The difference of the two resistances consists in this case, therefore, of the oblique frustrum Q R.

Now it can be easily demonstrated that the oblique frustrums M L and Q R are similar, and that being similar but not equal, the greater frustrum has the least resistance.* But of these frustrums have been shown to consist the difference between the two resistances in the two cases.

Now it is evident that the total resistances, separating both the surfaces K and N from the outer surface, are increased by the extension of the outer cubic surface to X X. Whilst therefore both resistances are increased, the resistance which constitutes at first their difference constantly decreases, so that the two resistances rapidly approach equality as the distance of the outer surface is increased.

For example, suppose the resistance of the frustrums K O and N M=each 100, and that of the oblique frustrum M L=70. Then, though the resistance of K O be increased to 400, by the surface E F H G being replaced by X X, the resistance of N R will be greater than 400, but cannot be so great as 470, or say 450. Thus although at first the resistances separating the equal surfaces K and N from the outer surface are as 100 to 170, or as 1 to 1·7, they are afterwards as 400 to 450, or as 1 to 1·12. But as the total quantity on the sphere will distribute itself inversely as the inductive resistance separating the different parts of its surface from the outer surface, the quantity on the equal surfaces K and N will be as 1·7 to 1 with the opposing surface E F G H; and 1·12 to 1 in the case of the outer opposing surface X X X.

The greater, therefore, the distance of the outer surface the less will the distribution on the spherical conductors depart from that uniformity, which would be produced by a concentric spherical outer surface.

The same considerations applied to the case of a cylinder with hemispherical ends, will show that the greater the distance of the outer surface, the more nearly will the distribution approach to that distribution which would be due to an outer surface, the same distance off, but of the same form as the interior conductor.

Thus, if A (fig. 62), represent a cylindrical conductor with hemispherical ends, then as we have seen, if the outer surface be at B C D, the distribution will be nearly uniform; if B F C H D be the outer surface, the density will be unequal, being greatest at C, but greater at B than at K. If the outer surface be situated at a great distance as compared to the conductor, as shown at A′ and D C B, the distribution will be greatest over the hemispherical end, having its maximum density at M. If the surface D C B be still further removed from A, there will be some distance beyond which, if further increased, scarcely any alteration in the distribution will take place, and if the outer surface be then altered to flat surfaces, then it could be shown by the same reasoning as that applied to the sphere in a cubic chamber, that the distribution on the surface of the conductor A will be scarcely altered by this change in the form of the outer

* In the case of similar prismatic solid figures, such as cylinders, or cubes, it is easily seen that their resistance (in the direction of their axis), will be *inversely as their homologous dimensions.* Thus taking two similar cylinders, A and B, whose diameters are respectively 1 and 2, then since they are similar, the length of B must be double that of A, and calling the sectional area of A=1, its resistance =1, and its length =1, then since B has a diameter double that of A, it has a sectional area 4 times A, and its length being 2, its resistance will be $\frac{2}{4}=\frac{1}{2}$. In the same way a cube of 1 foot will have double the resistance of a 2 feet cube, and treble that of a 3 feet cube.

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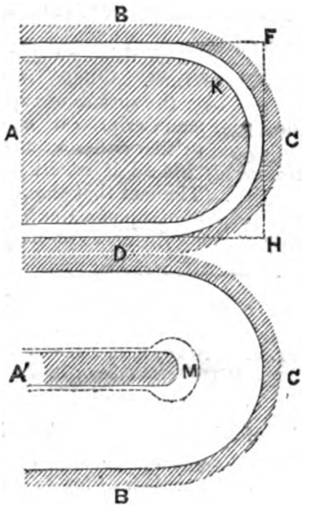
surface, from a cylindrical and hemispherical surface to a series of flat surfaces.

Fig. 62.



The distribution on the outer surface will always depend also on its own form and on that of the interior conductor; but when the distance that separates them is great, the distribution on the interior conductor may become nearly uniform, whilst that on the exterior surface will remain unequal. Thus in the case of the sphere B C D, fig. 65, in the cubic chamber, E F G H, the distribution on the surfaces O and L of the outer surface will be more unequal than on the surfaces K and N of the sphere; for the quantity on the surface O is equal to that on the surface K, and that on the surface L is equal to that on the surface N, and we have seen that the quantity on K was greater than that on the equal surface N, whilst therefore these unequal quantities are, in the case of the interior conductor, distributed on the equal surfaces K and N; the opposite and similar unequal quantities are, in the case of the outer surface, distributed on the unequal surfaces O and L, the *greater* quantity being on the *smallest* surface O. The difference of density between O and L will be greater, therefore, than between K and N.

When the outer surface is constantly extended, we have seen that the resistances of the cones K D and N R constantly approach more nearly to equality; if we suppose the outer surface so distant that we may suppose these resistances equal, then the quantity on the terminations of the two cones will be equal; and as the surfaces K and N are equal, the density on their surfaces will be equal; but as the surfaces D and R can never be equal (but will always bear the same ratio to one another), the densities on them can never be equal, however distant the surface X X be from B C D, although there will be less difference between the density on them than between the surfaces O and L, for whilst in the former case we have equal quantities distributed on unequal surfaces, in the latter we had unequal quantities on proportionately unequal surfaces, the greater quantity being on the smaller surface. If the distance of the outer cubic surface be therefore constantly increased, we see that the distribution on the sphere B C D will constantly and rapidly approach to uniformity, but that the distribution on the outer cubic surface will at first become a little more equal, and then maintain the same inequality of distribution, whatever may be the distance which separates it from the interior sphere.

If now, when the two surfaces are situated at such a distance as to produce practically equality on the sphere, the outer surface be altered to a spherical surface, it will itself, from what has already been said, have equal distribution; but since that on the interior sphere is already uniform, the latter will not be altered. When the outer surface is situated at some distance from the sphere, the shape of this outer surface is immaterial therefore to the distribution on the sphere, but the more will the distribution on the outer surface depend on its own form, and be independent of the form of the interior conductor.

If the interior be a cube instead of a sphere, then the greatest accumulation will be at its edges and corners, and it will be easily understood, from what has been said in the reverse case, that although, if the outer surface be very close, its form will affect the distribution on the cubic conductor, yet if it be very distant, the form of the exterior surface will scarcely affect the distribution on the interior conductor, while the distribution on the exterior surface will become more and more dependent on its own form.

To recapitulate, therefore, when the surface of a charged conductor is entirely surrounded by another surface, on which the opposite and equal charge must exist, the distribution on both surfaces depends on the form of each of these surfaces; but the greater the general distance separating them is, as compared to the dimensions of the interior conductor, the less will the distribution on the conductor depend on the form of the exterior surface, and the more, therefore, will the distribution on the interior surface depend on its form alone; and in the same way the more will the distribution on the exterior surface be dependent on its own form, rather than on that of the interior conductor.

Thus in the case of a small spherical conductor placed in the centre of a large cubic room, the distribution on the sphere may be so nearly uniform as to avoid detection in practice, but the density of the opposite and equal state on the surrounding surfaces of the room will be very unequal, being greatest at those points on the sides nearest to the sphere, and least at the angular points. If the spherical conductor be altered to a cube of about the same size, the distribution on it will become very unequal, and will be greater at its angular edges than on the centre of its flat sides, and greater still at its angular points; but the distribution on the room will be scarcely altered by this change. If now the room be altered to a spherical one, the distribution on the room will be greatly altered, and will become much more uniform, whilst the distribution on the cubic conductor will be scarcely altered from its previous unequal condition.

(*To be continued.*)

BONELLI'S TELEGRAPHIC APPARATUS AT THE INTERNATIONAL EXHIBITION.

In an age so marked by fertile and rapid invention it would be presumptuous to suppose that any discovery should represent the ultimate condition of any science, still we think that the system of telegraphy invented by the Chevallier Bonelli may safely be asserted to be an immense and most important stride towards perfection in the department which it illustrates. For many years the attention of telegraphists, and the hopes of the public, have been directed to the possibility of automatically reproducing an original dispatch. Two difficulties have, however, militated against all the attempts which, involving an amount of inventive genius, constructive ability, and scientific research, of which only the initiated can form a conception, have been made. The one, polarization, applying to strictly electro-chemical processes; the other, synchronism, applying with almost fatal effect to even such triumphs of genius as the recent masterworks of Hughes and Caselli.

To emancipate himself, therefore, from these all potent enemies, were directed the first efforts of Signor Bonelli; the one has been neutralized by a system of counter currents, the beauty of which can only be appreciated by those who have deeply studied the question, the other, by an arrangement as simple in fact as it is wonderful in effect. Dismissing all idea of producing the desired result by any complex perfection of the terminal machines, the inventor at once decided to reverse the system hitherto adopted, and, by making use of a compound line, to derive from the simplest instruments all the power and facility which he desired. The correctness of M. Bonelli's data was at once acknowledged, and a company has been formed for the purpose of carrying out his ideas upon a scale more than sufficient to answer all objections. A line between Manchester and Liverpool upon this system will in a few weeks be opened for public service.

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We may mention that the Act under which the company are laying their line was passed last session, the promoters having taken the effective course of setting up the machines within the walls of the House, in order to satisfy those who were to legislate upon the matter of the validity of their claims to public support.

We will endeavour briefly to describe the *modus operandi* of Signor Bonelli's system.

Let the reader suppose himself to be the operator; before him he will find an oak table, 67 feet in length 17 to 18 inches wide, along the centre of this table runs a miniature railway, terminated at either end by a spring buffer, and spanned midway by a kind of bridge 6 inches in height and 2½ or 3 inches wide. Upon this railway is placed a species of wagon, 1 yard long and 5 inches wide, 3½ in height, running upon 4 brass wheels: on the surface of this wagon are two long rectilinear openings—the one occupying the upper half and destined to carry the message which is to be sent, the other occupying the lower half, and intended for the message which may be to be received, upon the bridge are two small metal combs, each containing a number of insulated teeth, answering in number to, and connected with, the insulated conductors of which the line is formed. The combs differ from one another, the one which is to despatch the message being formed of so many teeth having a certain freedom of action is on the side of the bridge farthest from the operator; the other, or writing comb, is formed of a similar number of teeth fixed in a block of ivory, and forms a perfect line, which rests with a slight but regular pressure transversely on the paper, and occupies the nearer portion of the said bridge. We will suppose that the tables have been tested, and that a number of messages have been sent for dispatch; these messages are distributed to a given number of compositors, who set them up in ordinary type with great rapidity; the first that is finished is handed to the operator, whose wagon has already been pushed to the upper end of the rail and is held there by a simple catch, he places this dispatch in the opening destined for it, and in the second opening he places a plate of metal upon which has been laid four, five, or six strips of paper prepared with a solution of nitrate of manganese; this done, he turns a small handle and watches if the operator at the other end has done his work; the wagon is at once freed from the catch, and is set in motion by a simple weight, the pace being regulated by a fan; the type of which we have spoken is thus brought under the action of the despatching comb, and runs lightly under its teeth from end to end; one half of the journey being made, the writing comb comes in contact with the prepared paper. If the operator at the other end has had a message to send it will have been printed in clear, legible characters, of a deep brown colour, answering with unerring fidelity to the forms over which the corresponding type comb has passed, while the operator (the reader) learns that *his* message has as surely been received; the message is stripped off, the wagon remounted, the type-box changed, and the process of transmission and reception repeated. All this, which takes so long to describe, is so rapidly accomplished that from 450 *to* 500 *messages may be dispatched per hour*, the passage of the wagon occupying 10 to 12 *seconds*, during which time a message has been sent and received at each end of the line.

It will be seen at once that it is morally impossible that any demand should arise that would *over-tax* the transmitting powers of this system, the whole question resolving itself into *rapidity of supply*. Now, ordinary compositors can set up a message of 30 words in one and a half minutes, this period is, of course, divisible by the number of compositors, 10 giving 10 messages each minute and a half, 20 giving 20 messages, and so on. By this happy application of electric science to the typographic art, it is believed that the price of dispatches will be reduced to a minimum, and the rapidity of distribution vastly increased, while the chances of mistake are almost annihilated, being reduced to the possibility of *typographic error*, in the first and only process in which error appears to be possible.

It is scarcely needful to say that the dispatch received is actually sent out; as the wagon descends it is stripped from the plate, passed for a few seconds under a stream of water, blotted off, dried by hot rollers, and put into the envelope, which is, by this time, ready to receive it.

When it is remembered that no existing system is capable of dispatching with a pair of machines more than an average of 25 messages per hour, and that these are transmitted and received in conventional signs, it will be evident that a great step has been taken, and the public cannot but be interested in what promises to produce so great a revolution in the science of telegraphy. The employment of young women as compositors is a feature which will recommend itself to many, while the reduction to sixpence of the price of a message, the greater rapidity of delivery, and the almost absolute freedom from error, are points of the value of which all can judge. The machines, which may be supposed to represent any two distant stations, are in operation on Tuesday, Thursday, and Saturday, from 12 to 4, in the Holstein Machinery Department of the Western Annexe, where the Electric Loom is exhibited on the alternate days during similar hours.

It is clear that the application of this system to *autographic* telegraphy is a simple question of time. What 7, or 8, or 11 wires passing by the agency of combs over the surface of type can accomplish, a greater number passing over manuscript, can equally perform; the same message, being of course written either on metallic paper with an insulating ink, or *vice versâ*, indeed it would be difficult to assign the limits of its application. The fact that the principle upon which the system is based has been tried upon a line exceeding 300 miles, renders its practicability for long distances no longer doubtful.

ON THE USE OF CYLINDERS IN LAYING SUBMARINE TELEGRAPHIC CABLES.

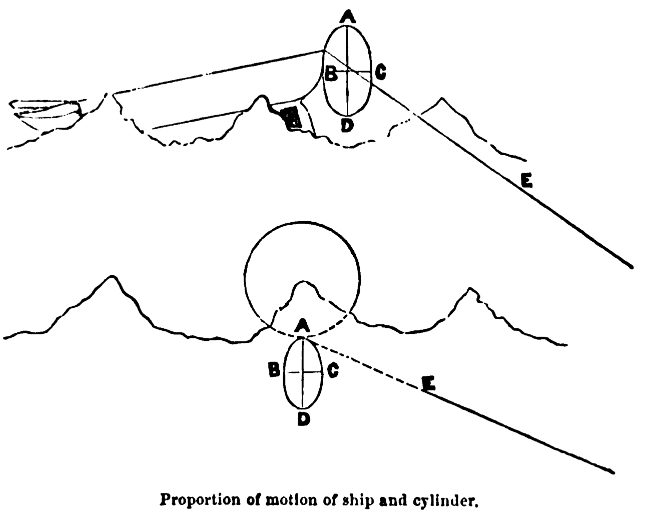
A PAPER READ BY CAPT. J. SELWYN, R.N., BEFORE THE UNITED SERVICE INSTITUTION, MAY 2ND, 1862.

[Continued from p. 46.]

ABOUT the orthography of this word { brake / break } there is a great difference of opinion, some spelling it one way and some the other, but I am inclined to think there is great similarity in their action as applied to this purpose, for the *brake* generally breaks the cable. The most perfect brakes which I can find are the paddle wheels, for these, according to the proportion which their diameters bear to the diameter of the cylinder, will either throw off slack or apply a per centage of strain, as may be desired. The necessary alteration being accomplished by the use of very simple mechanical appliances which I will presently describe; and more, they will resist the *dragging* off of cable, never absolutely, but, as the squares of the velocity with which it is sought to be done; so that any strain due to the rise and fall of a wave will be given way to, but the pulling off of cable in excess of the rate at which the ship is going through the water will be effectually resisted.

The appliance above referred to, and which is shown in the patent drawings,* consists of a clutch, fixed on the fore part of the frame on each side at the spot where the centres of the paddle floats pass during the revolution of the wheels. This is moveable on its axis by pulling ropes from the ship. If the one end be projected forward it will encounter the arms, which, like spokes of a wheel or capstan bars prefixed on the heads of long screw arms, and these, when moved, cause the recession of the paddle floats to their common centre. If the other arm of the clutch, on the contrary, be the one projected, then the screws are turned in the opposite direction, and the floats, instead of being "reefed, are expanded." But this apparatus has been contrived more in deference to the views of others than my own conviction. I do not anticipate, though it would undoubtedly fulfil its object, any necessity for its use while laying cable. To return to our gale and its difficulties. If the wind be astern I do not know any limit to the speed with which the cable may safely be thrown off in the path of the vessel, as it certainly will be by the revolution of the cylinder. If the gale be abeam a current course will be shaped, or rather

Diagrams Nos. 3 and 4.



Proportion of motion of ship and cylinder.

the lee way must be allowed for as usual, and no fear need be entertained that the cylinder will not "come after the ship" perfectly square, for we

* The number of the patent is 2884.

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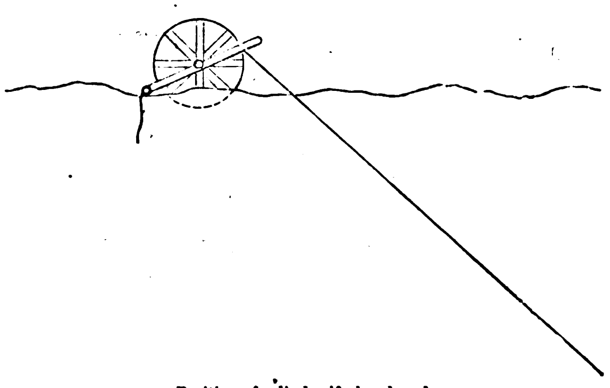
are not towing as ordinarily by the apex of a triangle, of which the stern of the ship towing is the base, the tow ropes forming the sides, and the hawse holes of the ship towed the apex, but in a totally different manner; the points at which the tow ropes are attached to the cylinder being more widely separated than those which they leave at the stern of the towing vessel. In towing a ship, as described above, if there be a heavy sea, she inevitably sheers about even when well steered, and from that cause, as also the heavy pitching, brings great strains on the tow ropes, if she do not even break them. The heavy pitching is caused by the fact illustrated in figs. 3 and 4, that the wave continues to raise the stern until it reaches the centre of the ships' length, causing thereby a motion in a vertical direction, much exceeding the height of the wave alone, in fact, one due to a multiple of that height by the half length of the ship.

I may here mention that I propose to use, as towing cables, Manilla hemp, combined with steel wire, which experience has shown to be the best means of obtaining great strength and great lightness. Four of these would be used, two of which as preventers. I should prefer to shackle them to chain cables on board the towing vessel, passing them out of the hawse holes, and hanging them outside the ship with proper stoppers and quarter-tackles. Also at the points of strain on the cylinder and the ship, I would make use of "buffer" or spiral springs, to diminish any jerking action. Counters for the number of revolution, by bell signal to the ship; lights for night-work, means of locking the cylinder and either stopping or retarding its revolution, or causing it to revolve by hand, would also probably be adopted, and I think most of the ordinary difficulties which can be foreseen have now been considered. But if a break down of engines, or other extraordinary difficulty should occur, it may be asked how we should then act. The engine stops. If you have, as you probably would have, a consort, you may without much danger or difficulty change places with her. There is no shifting possible, if the cable is coiled on board a ship. She may, it is true, be taken in tow, but I have already shown why it is much more difficult to tow a ship than this cylinder, not as regards the rate, but the breakage of tow ropes. But if the tow ropes should, with the cylinder, be unfortunately carried away in foul weather, you would, of course, soon make fast again; while in a gale the cable will take about two hours, or perhaps more, before the curve, which I shall presently show to exist during the laying, will have sunk sufficiently to allow of a fair strain being brought upon it. Then the cylinder (fig. 5) will of

Diagram No. 5.



Position of cylinder if abandoned.

itself turn round and ride to the cable, giving off cable slowly in answer to any strain, but resisting any rapid dragging of it off, by the beating of the paddles on the water, and the ship must lie by it until the gale moderates, or she can in any way get it in tow, which might not be attended with any great difficulty. But here, again, with proper management, I consider that this breaking adrift is an unlikely occurrence. There is no object to be gained in forcing the ship ahead in such a way as to endanger the tow ropes. I do not believe there would be any difficulty in having a crew of 10 men or so on the cylinder frame during the whole operation, if it turned out to be desirable, and would cheerfully volunteer to take charge of them myself. I *know* that a ship in a gale of wind may founder, particularly if she has, or has had, telegraphic cables coiled in her holds and on her decks, and is either, therefore, over weighted or not ballasted, while I am satisfied that this structure would be almost, if not quite, unsinkable by anything in the shape of wind or sea. If it should even leak, which is little to be feared in such a vessel, cask, or cylinder, proved, as it may be, by hydrostatic pressure, then it may be made to pump itself out by very simple means whenever it is revolving, as is done every day in our sugar refineries and other works where large cylinders heated internally by steam have hollow axles, with scoops attached inside as radii. These take up the condensed water from the bottom as they pass through it, and deliver it at the axle. If it be desired to lift cable, which has already been laid, this may be done by making fast to the after part of the cylinder frame, and towing in the reverse direction. The paddles will, as before, cause revolution, and wind up the cable. Under running may also be accomplished in the same way by taking two or three turns of the cable round the cylinder, and towing, or slowly moving, the cylinder in the direction which you wish to raise. For these processes in any moderate depth of water, say 300 or 400 fathoms, the cylinder would be most valuable, while, even in greater depths, it might sometimes be successful where any other means would fail. In fact, any cable which would bear its own weight might be thus recovered or repaired. As the cable is, by this system, not exposed to any mechanical violence, as it is always in water, and may be tested in water during the whole of the reeling on, and of the outward voyage it becomes almost certain that a mere gutta percha covered wire could be laid successfully. I have recommended, and I continue to advocate the employment of internal steel wire, to give strength; but I should not consider it indispensable for laying alone, if these means be employed. Yet I am no admirer of excessively light cables, which it is now the fashion to praise. Surface currents cannot be ignored, and they are greatly more to be feared as the specific gravity of the cable is decreased, while, as we may wish to lift the cable, or some portion of it, for repair, strength is by no means to be neglected. To place steel or iron wire outside a cable, where the salt water can get at it, after whatever lapse of time, is only to ensure its destruction by chlorides or oxides. It has been sought to remedy this by means which I can only compare to those adopted by an elderly lady of my acquaintance. She bought a Turkey carpet, not to be too roughly visited by the winds of heaven, or the feet of the profane, so she covered it carefully with an Indian mat. But this also was too good to be ill-used, so she finally applied a brown holland over both. So it is with a telegraph cable; we first construct the two essential parts—the conductor and its insulator; then we set to work to combat a shadow. We ignore the reduced specific gravity, and treat the wire as if it alone were to be suspended in water. Under this impression we construct an outer system of wires enveloping the cable, as in the arms of death. These, again, we are now covering with an insulating material, and it is probable that we shall perceive that the latter will also require to be protected by something else. Unfortunately, in this case, the brown holland is likely to be more expensive than the Turkey carpet. One electrician, whose cables are very beautiful to look at, has really put a larger copper conductor, in the shape of sheathing, outside his cable than there is in it, and I strongly advise him to put an insulator outside that again, if he does not desire to throw away the copper or brass outside altogether. It cannot contribute to strength, for if copper could support its own weight in water, it would be as well done by the small conductor inside. It professes, I know, to save the insulator from ill-treatment by cable layers or munching by mollusks; but, is ill-treatment necessary? and will mollusks, where they do exist, be more injurious to gutta percha than salt water to copper? As for *spiral* iron or steel wires outside a soft core and straight conductor, I can find no words sufficiently strong to express my astonishment at such a transgression of all mechanical laws—in such a self-evident fallacy. They are unprotected from rust or metallic veins on the bottom, they compress the soft core, and at the same time elongate and bring all the strain on the copper wire, which they ought to sustain. They are liable to kink and certain to decay. They present, in short, the best possible contrivance of "how not to do it." I have been told that the iron wires always broke first in the experiments; but, I am sure, that had the test been applied of hanging a weight down a well by one of such cables, we should have had a very great tendency to untwist on the part of the spiral, and a corresponding elongation of the copper wire; of course the iron wire would even then, break before the copper, but you would indefinitely attenuate the conductor, which, I presume, would not be considered desirable.

But with cables I have very little to do. Whatever they may be, I will undertake to lay them, D.V., in the same state in which they left the manufacturers hands, and more, no telegraphist can expect from seamen.

I would by no means be understood to say that a cylinder should be built and sent at once to the work of laying an Atlantic cable without trial. There can be no reason why full and satisfactory experiments should not be made previously; but if, as I hope, the opinions of many able men, whom I have consulted already, as well in the naval as in other professions, and who are nearly unanimous in their belief in the feasibility of the plan, if these opinions are still farther confirmed by the verdict of this Institution, then, surely it is worth while by the expenditure of a few thousands, to try whether a stop may not be put to those failures, which have already swallowed up a million and a half sterling, and so shaken public faith in telegraphic submarine communication, that no proposition which involves a recurrence to the old method of coiling in ships, will ever be listened to with favour by the Government or the nation. I said the expenditure, but, I am prepared to show, that other uses could be profitably found, for such a vessel as I propose, even if it did not fulfil the sanguine expectations which my friends and I entertain of success in laying cables by its means. For the necessity of storing submarine cables after manufacture, in water, has led in some instances, to the construction of tanks on purpose, even there, the water has to be changed, and, if possible, kept cool, by pumping. But such a cylinder as this, would, if left moored in a tideway, keep rotating, and the cable would be perfectly safe on it, whether as regards mechanical violence or raised temperature. If, in spite of every care, the testing should show a fault while laying, supposing the fault to have gone out, it would be possible to reel it up again

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by turning in the opposite direction, or by a hand motion given to the cylinder from the frame. If the fault were discovered while still on the cylinder, as there are about 31 miles in each layer the operation of laying may be stopped, and the fault be cut out whenever necessary. But faults can scarcely be expected to occur when a cable is treated as it would be on this principle. They are more likely to exist or be caused, where the cable in a hold, and during its coiling into it, has to be subjected to a handling, which, even where every care is taken, is too likely to be attended with accident, and which gives opportunities for wilful damage that have not always been passed over without harm. Here, on the contrary, nothing but water ever touches the cable, after or during the coiling on, the very coiling is, to speak correctly, now changed to winding or reeling on, which is far less likely to injure the cable, and the difference of which any seaman will readily understand. A similar motion in unwinding or paying out, will do away with all necessity for brakes, and most of the causes of breakage. I have now, I venture to hope, sufficiently explained a system of laying and generally treating submarine telegraph cables, which at least cannot be said to be objectionably complex; and I hope that a free discussion of its demerits, or otherwise, may bring out all those "No's" which are much more valuable to every inventor than any number of "Yes's." Here, as at the Naval Architects Institution, where I recently been kindly permitted to read a paper on the same subject, I am fully conscious of the great competency of my hearers to judge the merits of the system, and, therefore, while thanking the members of United Service Institution most warmly for their goodness in allowing me thus to bring the matter before them, I have only to beg for an impartial consideration of the subject, and that I may have the opportunity of answering, if that be possible, any objections which may suggest themselves now or hereafter. One word more, and I have done. There may be objections to be made, and minor difficulties to be overcome in this, as in every other novelty; but there is nothing that a seaman need fear.

On the other hand, I fearlessly maintain that unless by a miracle, no cable could ever be successfully laid over such a stretch as the Atlantic by coiling it into a hold at the commencement, and more, that whatever may be said, no cable has ever been laid, either by Messrs. Glass and Elliot, or others, which approaches such conditions as are here to be met. The Toulon and Algiers cable was only laid in pieces, so to speak. The first attempt took them nowhere. The second as far as Minorca, and the third from Minorca to Toulon. Is this such a success as ought to be, or can be referred to as promising another, in laying a cable across the Atlantic? Is the Red Sea a success? Is the Alexandria and Malta, laid in a continuous length across deep water? Ill treated as it has been in a hold, they even now fear to work through it at the speed they would otherwise attain.

No; if not this plan, then some better one; but let it at least be one which seamen can approve; not a clumsy attempt to overlay landsmen's difficulties with landsmen's expedients, which are discovered successively —after the cable is broken—to have been mistakes. I can compare the proceedings hitherto to nothing so well as the attempts at pulling (rowing landsmen call it) of a greenhorn in a boat. He seizes on an oar, possibly even adventures on the stroke oar, if he is not speedily ejected. Then his miseries begin. Perhaps he catches a crab; probably he breaks his oar; and it is always the fault of somebody or something, not himself, that he does not succeed. At length, some old seaman, pitying his troubles, "double banks" his oar, and teaches him practically the value of that turn of the wrist, which seems easy enough to look at, but nevertheless takes some time to attain. Seamen as a body are generally very ready to communicate their knowledge to those who come among them from the land, more so than most professions or trades; but neither their goodwill, nor even the undoubted aptness and acquisitive talent of telegraphic engineers can make it possible to compress the learning of years into the compass of a voyage or two, lasting each a fortnight or so. Such a space of time is barely sufficient to overcome the rebellion of the stomach, or to master the mysteries of the soup plate. A very clever fellow perhaps learns in addition not to hold on to a slack rope, nor to seek the weather gangway on dire occasions; but the greatest progress which can be expected is, after all, as in the case before us, that the tyro should have learnt how he can *not* do it, and be willing to confess that, after all, it is a nautical question, how to carry out great operations at sea, which can only receive its proper solution from seamen.

To them, therefore, as represented by this Institution, I turn for approval, and if they do sanction my labours, I have no doubt that the telegraphists will join us, heart and hand, in carrying to a really successful issue this magnificent work, which I firmly believe, is yet destined to play its part, under Divine Providence, in the spread of that universal peace—of that knowledge of Him, which shall one day cover the earth as the waters cover the sea.

THE PATENT LAWS.

The very unsatisfactory state of the patent laws has been brought before the House of Commons with a view of obtaining a royal commission to enquire into the working of that law. Sir Hugh Cairns, who moved the address praying Her Majesty to issue the Commission, makes the following statement with regard to the present state of the law—"The patent was taken out, about that year, by a Scotch gentleman, a Mr. Menzies, and it was for an invention for protecting bottles by capsule tops. It was, no doubt, a valuable invention, and it was litigated in Chancery and in the courts of common law, and had been very lately argued before the House of Lords. The solicitor for one of the parties had been kind enough to furnish him with a statement with regard to the costs. The solicitor for the plaintiff informed him that his clients costs amounted to £14,497., and he estimated the costs of the defendant at £10,370. So that the costs of the two sides for the litigation of this patent for the capsuled bottle-tops amounted to £24,857! Those figures proved that the present tribunal for the trial of patent cases, was at all events, not a very cheap tribunal. But he thought the complaint was also just that it was not a satisfactory tribunal. He did not think that any complaint was made of the head of the tribunal. It was held by some that there ought to be a "patent judge." He could not help thinking that there enough judges already, and that a new judge to try patents would produce rather too great a subdivision of business, and would probably result in his having very little business to do. But a more serious question was connected with the kind of jury in these cases. The other day a trial took place with regard to electric telegraph patents. There were many experts examined. There was a great controversy whether the patent had been anticipated by a prior invention. At last the jury took up their hats and said they must decline going on with the case, for that they could not understand anything about it. This was a very wise course, and one which he thought might be wisely followed by many other juries. Juries were often led, he would not say by counsel, but by experts; and at last they decided, not as they understood the cases, but as they inclined to belief in the experts of one or the other side."

ROYAL COMMISSION.—LAW OF INVENTIONS.

Lord Proby, Comptroller of Her Majesty's Household, appeared at the bar, and stated that he was commanded to present the following letter from Her Majesty in reply to an address from the House:—

"I have received your address, praying that a Commission may be issued to inquire into the state of the law relating to letters patent for inventions, and have given direction that a Commission issue for the purpose you require."

The message was ordered to lie upon the table.

Proceedings of Societies.

INSTITUTION OF CIVIL ENGINEERS.

May 13 *and* 20, 1862.—John Hawkshaw, Esq., President, in the Chair.

Abstract of a paper on "The Malta and Alexandria Submarine Telegraph Cable," by Mr. H. C. Forde, M. Inst. C. E.

It appeared that, in May, 1859, Her Majesty's Government determined, that a cable should be laid between Falmouth and Gibraltar, and the late Mr. Lionel Gisborne and the Author were appointed joint engineers. Subsequently, and after some progress had been made with the construction of the core and the outer covering, it was proposed to use the cable to join Rangoon and Singapore. The idea was, however, abandoned, and, in January, 1861, it was decided that it should be laid between Malta and Alexandria, an operation which was carried out in the summer of that year, the communication having been successfully completed on the 28th October, 1861.

The recommendations of the late Mr. R. Stephenson and Sir Charles Bright, as to the form and size of the cable to be used between Falmouth and Gibraltar, were then referred to; and it was stated that iron covered cables, of three sizes, were designed for the varying depths up to 600 fathoms, and for the greater depths across the Bay of Biscay, a cable covered with twelve steel wires, each enveloped in a hempen strand, laid in a spiral form. The latter was abandoned when the destination of the cable was changed: but the other forms of outer covering were retained, as considerable progress had been made with their manufacture. If it had been known at first, that the cable would be laid in comparatively shallow water, a different design would have been adopted. The outer wires were much larger than those of the Atlantic, the Red Sea, and the other Mediterranean cables containing a single conductor, and the conductor was nearly four times the size of the Atlantic cable, and twice that of the Red Sea cable.

The contract for the manufacture of the core was entrusted to the Gutta Percha Company; the contracts for the outer covering and for thirty days after completion, were let to Messrs. Glass, Elliot, and Co. The conditions of the contracts were then given in detail, the main

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features being that the core and the cable were to be kept continually under water, during the manufacture and the laying, and that the electrical tests were to extend from the commencement in the manufacture until thirty days after submersion of the whole line. The different processes involved were next described, and it was stated, that under a pressure of from 600 to 800 lbs., the electrical condition of the core improved about 10 per cent. The relative resistance per knot, both as to conduction and insulation, of the Atlantic, the Red Sea, and the Malta-Alexandria Cables, was represented by the numbers 1, 4 and 37. It was requisite that great care should be observed in making the joints of the core, of which there were four thousand two hundred in the Malta-Alexandria line, as the slightest imperfection in any one would be attended with danger.

A difficulty having arisen in keeping the cable permanently under water, one portion became exposed to the air, and was allowed to dry. When tested, a loss of insulation with increased resistance in the conductor, was observed. An investigation by Dr. W. A Miller, F. R. S., showed, that this deterioration was due to heating, from the effects of oxidation. It was consequently resolved, that the original idea of fitting the two ships with water-tight tanks should be carried out. The way in which this was accomplished, and the manner of coiling the cable on board, were then alluded to. The eye of each coil was fitted with an open framework of timber, by which arrangement a fault was cut out of the centre of a large coil, without its being necessary to uncoil the whole cable as would have been the case with a solid eye.

Previous to commencing the operation of laying, the route was most carefully surveyed by the ships of the Royal Navy, when it was ascertained that the Admiralty charts were in parts incorrect in latitude, and were deceptive as to the soundings, the general depth, and the conformation of the sea bottom being very different to what they were represented to be on the official charts.

Each ship was fitted in the following manner: A large V sheave, furnished with a small friction band, was suspended above the centre of the hold and over this the cable was led. The paying out apparatus, placed on one side of the stern consisted of three V sheaves, in one vertical plane, and parallel to the centre line of the vessel, each sheave being provided with a friction strap. The cable was passed over these sheaves under three weighted jockey pulleys to the brake drum, round which it took three or four turns; then over a fixed sheave and under a moveable weighted pulley, into the sea over a fixed sternwheel at the level of the last sheave. The dynamometer employed was similar to that used on the occasion of the successful laying of the Atlantic cable.

The first portion of this line was laid between Malta and Tripoli, the greatest depth being 420 fathoms. The cable was paid out at an average rate of 4·94 knots per hour. The maximum strain to which the heavy shore end was subjected was 20 cwt., but with the main cable this did not exceed 12 cwt. The estimated slack paid out in the deep water was not quite 5 per cent. No difficulties of any kind occurred until attempts were made to splice the main cable to the Tripoli shore-end, which had been laid by another ship. Nine unsuccessful attempts were made, owing to bubbles forming under the fresh gutta percha, but by cutting off a length of 25 fathoms of the shore-end, a perfect junction was effected. The remaining cable on board this ship was laid in the direction of Benghazi, the maximum depth attained being 150 fathoms, the average speed of paying out 5·3 knots per hour, and the greatest strain 9 cwt. The cable next laid was part of the third section, commencing at Alexandria, and extending nearly 300 miles to the westward, towards Benghazi. The roughness and irregularity of the bottom rendered this operation very critical; but by carefully selecting and laying out the route to be pursued, after accurate soundings had been made, and by only paying out in the daylight, it was successfully completed. Six days were occupied in laying 128·8 knots of heavy cable and 153·32 knots of main cable, or a total length of 282·12 knots. Thirty-two buoys were laid down to mark the route, and upwards of 60 different courses were run. The maximum depth of water was 102 fathoms, the minimum, for a short length, was 13 fathoms, and the average 33 fathoms. Subsequently, the second part of the third section between Alexandria and Benghazi, and the second part of the section between Benghazi and Tripoli were laid, and the communication was established. No accurate estimate could be made of the actual slack paid out, but as a general rule in depths under 100 fathoms, from 2 to 2½ per cent. was the utmost that could be got out of the ship when the cable was running quite free. The angle at which the cable was paid out ranged from 40° to 45°. The maximum speed was 7·15 knots, the minimum 4·5 knots and the mean 5·25 knots per hour.

Respecting the tests during and after the laying, it was observed that as the cable was paid out, its electrical condition invariably improved; the highest resistance being found in the deepest and coldest water, and the lowest, in the shallowest and warmest water. Experiments as to the rate of working, showed that the speed attained agreed very nearly with that which had been anticipated, namely, five words per minute through a length of 1,100 knots, except through the short sections, where the limit of the speed depended simply upon the skill of the clerk.

The communication was accompanied by a map; showing the general course of the cable, by a longitudinal section of the sea bottom, and by diagrams of the electrical tests. Specimens of different cables were also exhibited.

THE second paper read was "On the Electrical Tests employed during the construction of the Malta and Alexandria Telegraph, and on Insulating and Protecting Submarine Cables," by Mr. C. W. Siemens, M. Inst. C.E.

Having been employed by Her Majesty's Government as the Electrician to superintend the manufacture and shipment of the Malta and Alexandria Telegraph Cable, the Author was in position to speak as to its actual state of insulation, at different stages of its progress, and as to its general superiority compared with former lines. The methods of testing differred essentially from those previously resorted to. This was the first line that had been tested systematically throughout; and the importance of a uniform and well devised system of electrical tests being carried on during the manufacture, shipment, laying and subsequent working of submarine cables, had been fully proved.

The covered strand of conducting wire, in lengths of one nautical mile, was placed for twenty-four hours in tanks filled with water maintained at 75° Fahrenheit. It was afterwards removed into a pressure tank containing water at the same temperature, and when uniformly heated, it was tested for conductivity and insulation, and the result expressed in units of resistance, noted. A pressure of 600 lbs. per square inch was then applied, and the electrical tests were repeated. Before any coil was approved, it was required that the copper resistance should not exceed 3·5 (Siemens) units, or possess 80 per cent. of the conductivity of chemically pure copper; that the gutta percha resistance per knot at 75° should amount, at least, to 90 million units, corresponding to about 80 per cent. of the highest insulation that could be obtained with the best gutta percha of commerce; and further, that the insulation should improve when the pressure was applied, which was invariably the case when the covering was sound. The coils were then transferred to Messrs. Glass, Elliot, and Co's works at Greenwich, where they were submerged in tanks until required for the sheathing machine. The sheath cable was coiled into large tanks and was always intended to be covered with water, but owing to a defect in the construction of the tanks, this regulation could only be partially carried into effect. It was also intended in the first instance, that the ships should be proveded with water-tight tanks to receive the cable during the outward voyage; but owing to the passive resistance with which every deviation from previous routine was usually met, this plan was not carried out, until the heating of the cable on board the S. S. *Queen Victoria* had proved, at great cost, that tanks were essentially necessary. There were other important advantages obtained through the adoption of the water tanks, by which the causes of failure in paying out were avoided, and the operation was rendered comparatively safe and easy.

In conducting the electrical tests of the Malta and Alexandria cable in the course of its manufacture, the chief object was to obtain throughout strictly comparative results. For this purpose it was necessary to adopt a standard measure of resistance, by which to express both the conductivity of the copper conductor and of the insulating covering. This standard measure had been supplied by Dr. Werner Siemens. The unit of resistance was that of a column of pure mercury, contained in a glass tube, one metre in length between the contact cups, and of one square millimetre sectional area, taken at the temperature of melting ice. As the testing apparatus had been already described in the Blue Book 'On the Construction of Submarine Cables,' it was not necessary to repeat it. In the Appendix to this paper, tables were given of the results of observations upon two sections of the cable, at various stages of their progress, between Malta and Tripoli, and between Tripoli and Benghazi; and diagrams were exhibited representing graphically these results. On comparing the insulation of the cables after being laid down, with the insulation observed shortly before on board ship, there was a decideed improvement after submersion. This was partly due to the pressure upon the cables, the insulation improving 2 per cent. on an average for 100 lbs. of pressure upon the square inch, and partly to the lower temperature at the bottom of the sea.

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For working the line Messrs. Siemens, Halske, & Co. had supplied ink-recording instruments, fitted with peculiar arrangements for discharging the residuary charge of the cable, and capable of being worked by exceedingly feeble battery power. Although the line was divided into three electrical circuits, messages were transmitted mechanically and instantaneously, at the intermediate station, by a system of double relay, or translation. By this plan messages could be sent instantaneously from London to Omsk, in Siberia, and there would be no electrical difficulty in establishing the same direct inter-communication between London and Calcutta.

Respecting the construction of a cable of more permanent character than any hitherto made, to which the Author had given much consideration for many years, it was observed that with regard to the insulating covering, nature seemed to have provided only two suitable substauces, india rubber and gutta percha, combining permanent pliability at all ordinary temperatures, with high insulating property. India rubber had a higher insulating power, a lower specific induction, and was capable of resisting higher temperatures than gutta percha; but the latter could be put upon the wire in a plastic state by a die process, and gave greater security against faults than the lapped india rubber covering. It was also less liable to receive accidental injuries, to become sticky or semi-fluid when exposed to the atmosphere, and resisted the action of water more perfectly.

The absorption of water by gutta percha, india rubber, and compounds of india rubber, such as vulcanized india rubber, Wray's mixture, and a compound with mica, under various pressures and temperatures, and from water containing different degrees of salt in solution, had been fully investigated. These experiments served to show that an increase of pressure up to 60 lbs. per square inch, did not increase the rate of absorption, which was found to be more rapid prom pure water than from sea water, and from sea water than from brine. Raw and unvulcanised india rubber absorbed water in greater quantities than the other materials; while next to gutta percha, vulcanised india rubber showed, both in fresh and salt water, the greatest insensibility to absorption.

The results of experiments on the insulating and inductive capacities of wires coated with india rubber, in combination with gutta percha, compared with those of special gutta percha and pure india rubber at different temperatures, were then given. The lengths experimented upon varied from 600 to 2500 yards. The specific resistance of special gutta percha decreased from 9·11 at 50° Fahrenheit to 1·50 at 80° Fahrenheit, or to about one-sixth of its original value; while the combination of india rubber and gutta percha, had, under the same circumstances, only gone down to about one-third of its insulation at 50° Fahrenheit. The inductive capacity of the combined india rubber and gutta percha wire, and of pure india rubber covered wire, was as 0·7 to 1. Notwithstanding the comparatively high insulating property of india rubber, its low inductive capacity, and its power to resist heat, its gradual dissolution in sea water was a circumstance which alone rendered it inadmissible for submarine wires, unless it was securely enclosed in another waterproof medium, and gutta percha appeared, in every respect, well suited for such outer covering. It was desirable, that the india rubber should be brought upon the wire without the application of heat, or solvents, both of which often entailed a gradual decomposition of that material, particularly when exposed to atmospheric influence in contact with copper. Dr. W. A. Miller had stated, that the liquefaction was the result of a process of oxidation, from which it might be inferred, that the effect could not take place where oxygen was excluded. It, moreover, was important to produce a perfectly cylindrical covering, and taking advantage of a peculiar property of india rubber cohering perfectly where two fresh cut surfaces were brought together under considerable pressure, the Author had constructed a covering machine which fulfilled the several purposes. Such combined india rubber and gutta percha covered wires had been tried under various circumstances, exposed to the atmosphere, to water or the moisture of the ground, for nearly two years without betraying any signs of gradual deterioration of the india rubber, or the appearance of faults. A circumstance greatly in favour of the bi-covered wire, was that gutta percha shrank upon the india rubber covered wire, and when any mechanical injury to the covering occurred, the yielding india rubber was forced into the gap, by the elastic pressure exercised by the gutta percha, and prevented the appearance of a fault.

The outer covering of cables, as hitherto constructed, was certainly the least perfect part. An iron sheathing was very necessary to protect the insulated core in shallow waters, but for cables in more than 30 or 40 fathoms of water, the iron sheathing was an element rather of weakness than of strength. It rendered the cable ponderous, its shipment expensive, the paying-out risky, and repairs impossible, owing to the difficulty of raising a heavy cable from a great depth under any circumstances, and the absolute impossibility of doing so after corrosion of the iron wire had made some progress.

When the Falmouth and Gibraltar cable was first contemplated, the Author, in conjunction with Mr. Forde, proposed to cover each iron wire with gutta percha, with a view to prevent oxidation; but the system was not acted upon except by way of experiment. Mere protection of the wire, was however, not sufficient in the Author's opinion. It was capable of mathematical demonstration, that in paying out a wire sheathed cable with a considerable strain upon the breakwheel, it would untwist while in suspension in the water, to a considerable extent, causing elongation of the core to the amount of say one per cent., or even more. On reaching the bottom, the strain and consequent twist would be released. Copper wire could not be elongated more than 2 per cent without receiving a permanent set; and it was also a well ascertained fact, that when telegraph core had been stretched any time beyond the limits of elasticity of the copper, the latter being henceforth too long for the more elastic covering, would tend to assume a serpentine form, and to push its way through the insulating material by slow degrees, particularly in places where short bends or kinks occurred.

Based upon these views the Author designed a sheathing of the following description:—The insulated conductor, or core, was passed in the sheathing works through a series of three machines in close succession. In passing through the hollow spindle of the first machine a close spiral covering of hemp, previously saturated in Stockholm tar, was applied in such a way, that each string was and remained under a given strain. The second machine was similar in construction to the first, but supplied a second covering of hemp wound in the opposite direction to the first. The rope thus formed, passed next through a stationery clip, with longitudinal grooves to prevent it from turning round in the operation immediately following, which consisted in the application under the influence of great pressure, of from three to six strips of copper, or other metal, which might best resist the action of sea water. These strips were accurately guided into the revolving covering tool, so as to overlap each other equally for nearly half their breadth, the pressure applied being sufficient to crush or socket the one metal down where it was covered by the other. This cable had no tendency to untwist; its extension with half the breaking strain upon it did not exceed one-half per cent., and being very strong, and of only double the weight of water, it would support about 8 miles of its own weight in the sea.

Considering that good ship's sheathing lasted about 10 years when the ship was at rest, and that the cable had two layers of metal, with hardened tar between, it appeared not unreasonable to suppose, that this sheathing would last at the tranquil bottom of the ocean from 20 to 30 years at least. Several short lengths of this cable were now being tried, under various circumstances, and the results, so far, were promising of success upon a larger scale.

After the meeting, Mr. F. C. Webb (Assoc. Inst. C.E.) explained a modification of the ordinary sextant, by which larger angles could be measured than with the instruments now in use. Two sextants (by Messrs. Fletcher, of Leadenhall Street) were exhibited, one on the common arrangement and the other on the modified principle.

It was stated, that when the arm of the common sextant was at zero, the lines of incidence and of reflection, of an object seen in the horizon glass, formed a certain angle with one another, both at the object and horizon glass; and that this angle, termed the constant angle, deducted from 180°, gave the extreme theoretical angle, which could be measured. Practically, this measurement was still further reduced, by the limits within which it was possible to reflect an object from a plane surface with accuracy, and which, if assumed as 170° instead of 180°, would give the angle from which the constant angle must be deducted to obtain the extreme angle capable of being measured. The smaller the constant, therefore, the nearer would this angle approach 170°, with a given amount of accuracy. It was observed that this constant angle was dependent on the relative position of the object glass, the eye piece, and the horizon glass, and was, in fact, the angle formed by a line drawn from the eye piece to the centre of the horizon glass, with a line drawn from the centre of the horizon glass to the centre of the object glass.

The reduction of this constant angle to a minimum was effected in the modification alluded to, by placing the eye piece very near to the object glass, and the horizon glass as far as possible both from the object glass and the eye piece. The extreme angle capable of being measured was thus considerably increased, and with conditions more favourable to accuracy; for whilst the angles of incidence and reflection in the object glass were not smaller than in an ordinary sextant,

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those in the horizon glass were constantly larger. With a given angle to be measured the conditions were more favourable to accuracy, since the lines of incidence and reflection formed larger angles with the reflecting surfaces, both in the object and the horizon glasses.

In marine and land surveying, and in taking altitudes of celestial objects with an artificial horizon (where the angle to be measured was double the altitude), this increase in the capabilities of the instrument was, it was believed, a manifest advantage.

ELECTRIC ANIMALS.

In addition to the electrical power with which every living being is supplied, many animals present the phenomenon of so large an accumulation of this fluid that they are enabled, at their pleasure, to give electric shocks to any bodies coming in contact with them. That the torpedo possessed this power was well known to the ancients; for Pliny informs us that when touched with a spear, "it paralyses the muscles, and arrests the feet, however swift;" while Aristotle adds, that it would benumb "men as well as the fishes which served for its prey." And Anthero, a freedman of Tiberius, was cured of the gout by means of its shocks. Appian, too, gives a distinct description of it; yet Francis Bacon, in the early part of the seventeenth century, speaks of this power merely as "an ancient tradition"—a specimen of half-assured credulity, which falls strangely from the pen of one who gravely informs us that he judges the making of gold "to be possible, but the meanes [hitherto propounded] to effect it, full of errour and imposture!" who recommends scarlet cloth as infallible in the cure of gout: and who declares that his warts were charmed away by a woman who was "farre from superstition!"

Fifty two years after the death of Bacon, some excellent engravings of the electric organs of the torpedo were published, which exhibit the progress natural science has made during that interval. In our own time, the great Exhibition of 1861 has furnished some very complete models of the whole of these organs, which were beautifully manufactured in wax from the most careful dissections.*

Europe boasts of several species of the torpedo, which principally occur in the Mediterranean. Humboldt enumerates five distinct species which are electrical; namely, *T raia*, *T. narke*, *T. unimaculata T. marmorata*, and *T. Galvanii*.

The *T. raia* is usually regarded as the type of the family, and as such must occupy our chief attention. Dr. Hunter found that the electric organs of this fish were placed on each side of the cranium and gills, occupying all the spaces between the upper and lower surfaces. Each organ consists of perpendicular columns, reaching from the upper to the under surface of the body, and consequently varying in their length according to the thickness of the part of the body in which they are placed. The figures of these columns are irregular hexagons, or pentagons, sometimes even approaching a quadrangular or cylindrical form. The number varies greatly with the size of the fish: on one very large individual, Dr. Hunter counted the amazing number of 1,182 in each organ. The nerves inserted in these organs arise, by three large trunks, from the posterior part of the brain, and, thence passing into the organs, are infinitesimally ramified until they lost to human ken. It is somewhat singular that organs analogous to those of the torpedo raia, have been discovered by St. Hilaire in other species of the ray family which do not possess any electrical powers.

A variety of experiments have been made, which clearly prove the shocks to be given at the pleasure of the fish; and also, that the frequent action of the organs is obnoxious to its life. The possession of one organ only is sufficient to produce the shock; and Mr. Todd asserts that "when the nerves and organs are cut, the torpedo loses the power of giving a shock, though it appears more vivacious, and lives longer than those in which this change has not been produced"—a hint which might be valuable to those whose "nerves" are the only great trouble of their lives.

Dr. Davy succeeded in communicating distinct magnetism to a needle by means of a torpedo, but failed in obtaining any igniting power, or even the slightest spark from it. Some years since, however, this was achieved, at the Adelaide Gallery, where an electric eel set fire to and destroyed a piece of silver paper in a glass cylinder. One end of the conductor was attached to the paper and the other to the eel, and thus the paper was consumed.

The animal seldom gives a shock unless previously irritated; and before anything is felt, a convulsive movement of the pectoral fins may be observed. When near death, the shocks are not given at distinct intervals, but resemble a continued battery of small shocks.

* In the department of Tuscany.

PRICES CURRENT OF INSULATING MATERIALS.

GUTTA PERCHA.

Small lots offering, for which very high rates are required.

Some of the few parcels of the late imports expected to be bought upon the market have been sold to arrive.

The importers are now looking for a considerable advance in price upon the last sales, owing not only to the reduced stock here, but also from the last accounts from Singapore being very little of fine there to be had, and at much higher cost.

A parcel under 20 tons is on the market to arrive, for which 3s. per lb. is asked by the importers, and from the present position of the article there is every prospect of the price being realized.

INDIA RUBBER.

Very flat, waiting the result of the large public sales at Liverpool, which were to take place on the 5th instant, consisting of about 300 tons Para, besides 40 tons of other descriptions.

Full particulars will be given in our next number.

Fine Java scarce ... ... 1s. 5d. to 1s. 6d. per lb.

June 5, 1862. WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	25 to 30	——
20	Do. B 7 per cent. till 1862 .	all	18 to 20	——
20	Do. C. " "	all	9 to 11	——
10	London & S. of Ireland Direct.	2	par.—1 pm.	——
Stock	Electric Telegraph . .	100	100 to 103	——
5	London District Telegraph .	4¾	8¾ to 8¼ dis.	——
10	Mediterranean Extension Tel.	all	3½ to 4½	——
20	Red Sea and India Telegraph	all	18¾ to 19¼	——
1	Submarine Telegraph, scrip.	all	3/8 to 5/8	——
1	Do. registered . . .	all	3/8 to 5/8	——
10	Do. " . . .	all	4 to 6	——
2	Telegraph to India . .	1	¼ dis. — par.	——
5	United Kingdom Telegraph .	8	2 to 1 dis.	——

THE ATLANTIC SURVEY.

We are glad to inform our readers that vessels for the purpose of surveying the route for an Atlantic cable are now being fitted out, and commissioned by Government. We trust that a telegraph engineer of experience in the laying and maintenance of submarine cables will be appointed to accompany this important survey; as there are many points to be determined, in regard to the route for a submarine cable, besides those obtained in the ordinary operation of an Admiralty survey, which those alone who are experienced in the maintenance of submarine cables can point out.

Telegraphic News.

INTERNATIONAL TELEGRAPHY AND THE INTERNATIONAL EXHIBITION.

The following letter has appeared in *The Times*:—

SIR,—Referring to the complaints alluded to in your notice on the International Exhibition of this morning respecting the delay in the delivery of telegrams, I beg to state, in explanation, that the Submarine Telegraph Company, being enabled by their seven cables to offer the greatest facilities for international telegraphic communication with most parts of the Continent and the East, made an application to the Commissioners a long time previous to the opening, to be allowed to take their wires into the building, and thus to afford the exhibitors the direct communication to and from the building to the various parts of the Continent.

The company's offer having been rejected, we immediately erected an office in the Cromwell-road, and delivered our messages, I believe without complaints, until Monday morning last, when, it will be scarcely credited, our messenger, with the telegrams in his hand, was actually refused admission to the building, and the immediate delivery of them thus prevented.

A season ticket being now purchased for the messenger, all telegrams sent to the Cromwell-road office are forwarded or delivered by this company with every possible despatch.

I remain, Sir, your obedient servant,
L. WALTER COURTENAY, *Secretary.*
Submarine Telegraph Company, May 31.

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ELECTRIC TELEGRAPH LINES.

COLONEL W. PATTEN asked the President of the Board of Trade whether it was the intention of the Government to introduce any measure during the present session for regulating the construction of lines of electric telegraph on public roads and lands adjoining thereto. He wished further to ask, whether in legislation during past sessions, a clause had been inserted in Bills rendering existing companies liable to future general legislation.

Mr. M. GIBSON replied that with regard to the last part of the question, as to whether companies which had obtained Acts of Parliament to construct electric telegraphs would be subject to future legislation, he believed that none of the Acts contained such a clause; but some of them, he believed about one half, had a clause which gave to Parliament a power of limited interference at the end of ten years. He had a copy of the clause, which stated "that at any time after the expiration of ten years from the passing of this Act, the regulations of the company with regard to the transmission of messages and the opening of streets, shall be subject to a revision of Parliament; and Parliament shall then require and enforce the adoption and performance by the companies of such modified or other regulations as aforesaid as shall be deemed necessary for the protection and convenience of the public." There was no clause as to general legislation by Parliament, but he proposed communicating with the chairman of ways and means recommending that a clause granting such power should be inserted in any Bill now before Parliament. As to the first part of the the question, the subject was one of considerable difficulty, it was undergoing consideration, but he could not undertake, as at present advised, to promise that any Bill relating to the question should be introduced during the present session.

FOREIGN TELEGRAPHS.

Mr. J. EWART asked the Secretary of State for India whether any proposition had been made to the India Council to aid the establishment of a line of telegraph between Singapore and India; and if so, what was the general nature of that proposition.

Colonel STUART asked the Under Secretary of State for Foreign Affairs whether an agreement was entered into in 1858 between the Government of Turkey and the Government of this country (or of India), for the construction of a line of telegraph from Scutari to Bagdad by the Turkish Government; whether it was not also agreed between the contracting parties that, on the completion of the telegraphic communication between Scutari and Bagdad a line of telegraph should be laid down from Bagdad to Kurrachee by the Government of this country or of India; whether it was not the fact that the line from Scutari to Bagdad was completed, surveyed, and reported on as fit for use, by a British officer, in December, 1860; and, whether it was not also the fact that no steps had since been taken by the Government of this country or India to continue the line of telegraph from Bagdad to Kurrachee in accordance with the agreement of 1858.

Sir C. WOOD, in answer to the first question, said a proposal had been made as to the establishment of a telegraphic communication between Singapore and India. The Indian Government were well disposed to such a project as part of a line to China and Australia, but they could not adopt it for purely Indian purposes. With regard to the other question, it was true that such an arrangement as was implied by the gallant colonel had been made for the completion of a line of telegraph to Bagdad, and also for a further line from Bagdad to Kurrachee. Nothing had, however, been done to carry out that arrangement.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

TELEGRAPH POLES ALONG THE COMMON ROADS.

To the Editor of THE ELECTRICIAN.

SIR,—I have read from time to time in your Journal notices of the contest now carried on between the Old Telegraph Companies and the United Kingdom Telegraph Company. I have myself no interest in either of the companies, more than that of the public at large, who wish to have their messages transmitted cheap and expeditiously. On the 27th inst. I took a walk along the Finchley road, and examined the northern line of telegraphs, and I must confess that after following the posts for several miles I was more pleased than offended with the series, besides it forcibly struck me as an amateur electrician, that it would be well were the old companies to send some of their officers to examine the very efficient plan adopted by the new company for insulating the wires. The insulators are kept exceedingly clean (and my journey extended from London to Leighton Buzzard), which prove that the necessity of good insulation was apreciated, and hence the realization of "cheap telegraphy." Along the railway the insulators were invariably very dirty, owing, I suppose, to their being exposed to the smoke and steam of the locomotive. The leakage along such lines must be enormous, and the expense of working correspondingly great. Why should so much rivalry and bad feeling exist in telegraphy? Surely the country cannot long remain at the mercy of intolerant monopoly. T.

To the Editor of THE ELECTRICIAN.

The copper plates of a Daniell battery are frequently eaten away in holes: out of a 12 cell trough perhaps one only will be attacked. The plates are in their right positions, and are charged exactly alike. What is the cause? IGNORAMUS.

Miscellanea.

HEAT AND MOISTURE.—In most ordinary cases of combustion moisture is generated. This may be rendered visible by holding a tumbler over a lamp or candle, when the steam which accompanies the other products of combustion becomes condensed upon the cold surface. It is a very necessary provision of nature that moisture should generally accompany heat. All gases when heated greedily absorb water and desicate everything within their reach. In some of the contrivances for heating air in dwellings this fact is lost sight of; the temperature being merely raised without the necessary supply of moisture. From this the most distressing symptoms follow, the heated air being almost irrespirable until it obtains its natural equivalent of water at the temperature given. In some constitutions even the dry easterly wind of this climate is productive of great discomfort. The materials for our lamps and candles fortunately contain the element hydrogen in great abundance, and thus supply moisture as well as heat. Coal gas is essentially composed of hydrogen and carbon; and it is a matter of importance that the latter element should never exceed a certain proportion to the former. Apartments heated by radiation from coal fires should never in winter be allowed to become desiccated, as the heated air, in the absence of other sources of moisture, causes the rapid evaporation of the insensible perspiration of the skin producing the sensation of cold. It is for this reason that a degree of heat can be readily supported in dry air, which if the air was saturated with water would produce the effect of scalding, a fact with which those who have used the oriental hot air bath, and the vapour bath, will be familiar. Evaporation always produces cold, condensation is always attended with the disengagement of heat.

MAGNETISM.—Dr. Gowan Knight, F.R.S., a London physician, in the years 1746 and 1747, proposed a method of magnetizing steel bars by gradually withdrawing the opposite poles of magnets from beneath them, the poles being in contact with the steel bars. Du Hamel, about the year 1749, made a further application of Dr. Knight's method of magnetizing. Two bars were magnetized at one time by being made the opposite sides of a rectangle, the other sides being formed by soft iron bars. Brugmans, in 1778, observed and recorded the repulsion of bismuth and antimony by the magnetic poles, thus laying the foundation of the science of diamagnetism. Dr. Ingenhouz, in 1776, proposed a mariners' compass, consisting of a magnetic needle enclosed in water or some other suitable fluid, in order to steady the needle. Coulomb, about 1780, propounded his double-fluid theory of magnetism: he also proposed a method of magnetizing by the "double touch," the bar to be magnetized being placed between two powerful magnetic poles. Cavallo, in 1786, made many experiments, proving that brass acquires magnetic power by hammering. Cassini, in 1786, discovered the annual periodical variation of the magnetic needle. Coulomb, in 1786 and 1787, established the law that magnetic force was really in the inverse duplicate ratio of the distances, by his Balance of Torsion, and by the method of oscillations.

THE NASCENT STATE.—The word nascent is from the Latin word *nascens*, and signifies being born. When water is decomposed, the two gases, oxygen and hydrogen as they are being evolved are said to be in the nascent state. In this state they are more ready to unite with other substances than they are after they have remained awhile separate. The same is true of other elements; just as they are in the act of being decomposed they are more ready to enter into new combinations. This property is rendered available in many chemical operations.

DR. WOLLASTON had a peculiar turn for contriving pieces of apparatus for scientific purposes. By means of his reflective goniometer, crystallography has acquired a great degree of perfection; and his sliding rule for chemical equivalents furnishes a ready mode for calculating the proportions of one substance necessary to decompose a given weight of another. The Doctor was accustomed to carry on his experiments in the greatest seclusion, and with very few instruments. His laboratory was sealed to even his most intimate friends. Dr. Paris relates that a foreigner once called on Wollaston with letters of introduction, and expressed an anxious desire to see his laboratory. "Certainly," he replied, and immediately produced a small tray containing some glass tubes, a blow-pipe, two or three watch-glasses, a slip of platinum, and a few test-tubes. Upon another occasion, after inspecting Mr. Children's grand galvanic battery, Wollaston, within a tailor's thimble, completed a galvanic arrangement, by means of which he heated a platinum wire to a white heat.

To Correspondents.

P. L. S.—The company you refer to is only another instance of what is to be expected when directors and shareholders are led by "speculative" engineers and concessionaires.

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The Electrician.

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CONTENTS:

	PAGE
Steps to Theory by the Practice of Electricity	61
Telegraphic Jurors for the International Exhibition	63
Some Considerations on the Principles of Electrical Conduction and Accumulation	64
Electrical Properties of the Tourmaline	66
Allan's Deep Sea Telegraph Cable	67
Some Magnetic Experiments	68
Military Telegraph Cable	69
Prices Current of Insulating Materials	69
Telegraph Shares	69
Telegraphic News	69
Correspondence	70
Miscellanea	72

STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 50.]

Electro Telegraphy.

259. LET it be supposed that we have condensed the air around the wire, *a c b* (fig. 35); then just in the same ratio shall we have increased the charging capacity of the wire, and consequently the quantity of electricity it is capable of receiving under any given intensity from the plus source. This has received an experimental verification at our hands, and has become an elementary part of our theory.

260. As the quantity of charge that may be accumulated under any given intensity on a wire, supposed to be stretched in the atmosphere in a straight line, and without beginning or end, varies in the simple ratio of the number of particles of air surrounding it within any given distance, it follows that its charging capacity would be greater if the particles of air were in a solid condition, because, if solid, many more particles would be contained in a given volume.

261. Now, as theory makes no specific distinction in favour of particles of air for sustaining induction and thereby conferring charging capacity, what would theoretically result in those respects from aërial particles closely packed around a wire, should result actually from its being enveloped in insulating solid materials of other, kinds especial attention being paid to having the outer surface of the solid insulator perfectly free from all traces of conducting matters; in conformity with this conclusion we should conclude that wires covered with gutta percha, or caoutchouc, before being raised into the atmosphere, condense upon their surfaces from a plus source larger quantities of electricity than similar naked wires; and, further, that those quantities upon a wire of given diameter increase as the solid insulator around it is made of greater thickness.

262. But all solid insulators need not be alike in conferring charging capacities on included wires under a given intensity of inductive action, because, perhaps, no two of them will contain in an equal volume the same number of particles; and it is to this theoretical causation that we ascribe the fact observed by Faraday, made popular by his doctrine of specific inductive capacities, and confirmed by the experience of telegraphists generally.

263. Although plus electricity on an aërial line thus finds more perfect induction when it is coated with a solid insulator, and, in consequence, can rest upon the wire in proportionately greater quantity under a given intensity, the charge it induces in the surrounding matter is unattended by any actual loss of its natural electricity. As in the case of the naked aërial wire, the electricity made plus by induction still retains its normal position, by reason of the insulation, though it be virtually dismissed from being attracted by its own common matter; and, therefore, on the discharge of the wire it can instantly be taken back again into normal repossession without any new motion, or its attendant inertia. Hence in such lines, as in naked aërial wires, the return charge is either inappreciable, or comparatively unimportant.

264. It is far otherwise, however, when we place a wire so coated with a solid insulating material, with its outer surface in contact with damp earth or water; for, in either case, we place the film of moisture lying against the insulator in a position to perform the function that our theory has ascribed to the outer coating of a Leyden jar, or tube. In all our subterranean and submerged cables the plus electricity that constitutes the charge of the wire, and from its surface propagates induction through the insulator to the conductor beyond, actually dismisses from it portions of its normal electricity, which it cannot regain on the discharge of the wire, except by establishing new electrical motions, and the overcoming of inertia. Under these circumstances the return charge must be comparatively very great and long in its duration.

265. The only way indicated by our doctrines to confer small charging capacities on the wires of our submerged cables, is to put around them great thicknesses of insulating material, so as to lessen the intensity of induction propagated through it to the conducting coating beyond, using, in preference, such of the solid and appropriate insulators as have been practically found to have the lowest inductive capacities.

266. By increasing the radius of the cylinders of solid insulating material around a wire, we may, therefore, according to our doctrines, either diminish its charging capacity, as just said (par. 265), or increase it as before stated (par. 261); but this seeming anomaly disappears when we bear in mind that the intensity of induction at the outer surface of the solid material, equal in the two cases, will experience elevation when the induction is transferred to the air which gives an inferior capacity and reduction when it is taken up by the conducting matter which bestows a superior capacity. All this, we presume, will have been made clear in former pages, and will now only need to be remembered.

267. With respect to the return current, there are circumstances indicated by our doctrines that we need more particularly to advert to. By our 2nd law of conduction, as we have explained in paragraphs 246, 247, the time occupied in getting a first signal along wires of unequal extent vary as the squares of their lengths, but still it is theoretically quite possible to shorten the periods intervening between the first and the second signs, or any two consecutive signs, so that the ratio they bear to one another shall approximate to the simple ratio of the lengths of the wires.

268. To understand this, we have only to allow for the transmission of every two consecutive signs insufficient time for the direct current to return upon itself; for it is evident that if the charge of the wire have not each time to be renewed, but only freshly propelled, then the case is brought under our 1st law of conduction. If electricity, whether in motion or at rest, has a tendency so to remain, as we say it must have in common with matter generally, a current moving along a wire will, by its momentum, outlive for some small portion of time the impetus which sent it forward; and having stopped and let the indicating instruments fall to zero, then some further small time must pass before the current can overcome its inertia, and set out on its return journey. Now, if the connection with earth be broken at the transmitting end of the wire and battery connection re-established there at the precise instant of time when the charge is in a condition of rest, after it shall have stopped and before it has begun again to move, no new quantity of electricity will be needed to traverse the length of wire, but only a new impetus given to the old quantity, and the signal will again be renewed.

269. This precise coincidence of time and electrical condition can in practice be only accidently attainable; and should it be missed, and the return charge in its full momentum be met by a new direct charge commissioned with a new signal, the time allowed by the manipulator for its transmission may expire while the momentum of the return charge is being overcome, and before the current can be turned again in the proper direction. Were

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this to happen we might send into one extremity of a long wire any large number of signals, few only of which might ever arrive at their destination; and we can be sure of preventing the evil only by waiting for a sufficient discharge of the wire, whence it is that a leaky wire sometimes promotes the speed of transmission.

270. We can now see pretty clearly through the question which at the present moment is engaging the attention of telegraphists with respect to the retardation experienced by messages sent along wires of unequal lengths; as it is evident on our doctrines that the inertia will be pretty much as the lengths when the return currents are adroitly intercepted, and as the squares of the lengths if they be allowed to establish themselves; there being but little latitude afforded for a partial departure from either ratio, for when once the current has fairly commenced its return journey, it may persist in the retrograde movement until it be nearly completed.

271. Theory, however, indicates a perfect mode of establishing even the greatest needful lengths of submarine cable without the drawback of any appreciable charge; and that being practicable, our inducements to adopt it are certainly very great; we might then dispense with intensity of voltaic action in our batteries, by which they are made costly for materials, and wear and tear; we should have no charge to leak out by default of imperfect insulation, making the outlets gradually larger, and eventually putting an end to the working of the line; and we should be rid of that return charge which so much embarrasses telegraphic transmission as well as other consequences of induction no less subversive of perfection.

272. The conditions for perfection in signalling by the submarine telegraph are really very simple, and we are convinced that by their aid the greatest distances ever yet contemplated may be worked through with a speed great enough to be remunerative and satisfactory. The new principles plainly indicate that the length of any particular wire may in effect be reduced one half. And this, be it remarked, is far from giving a due conception of the improvement that would be effected in the speed of signalling; it simply denotes the relative times occupied in the transmission of a sign, and not the rapidity with which one may follow another, which is in truth the only important practical consideration. The former is a question of very little interest, as under all circumstances the time occupied by the passage of electricity through the longest conductors is insignificant; but on the latter success practically depends. Instead of our signals being retarded, as it is said they often are, and under the present construction of our apparatus may continue generally to be, as the squares of the lengths of the wires, in comparison with one another, the retardation would, by changing the present system for the one available, be made to vary simply as the several lengths. After comparing the velocity of transmission with the retardation occasioned by the return of a charge to the extremity of a wire whence it set out, the Government Submarine Telegraph Committee tells us that, "If a measured charge, after its transmission through the wire, were discharged at the remote end in an equal interval of time, this retardation would be of little importance, as the charges at one end and the discharges at the other would succeed each other in the same order, and with the same intervals between them; but as the discharge in great lengths of wire occupies a much greater time than the charge, if a new charge is given before the wire is completely cleared of the former, although the charges may be separated by strongly marked intervals, the discharges would be confounded into one, and it would be impossible to distinguish the various succession of currents." "Various expedients have been resorted to, to increase the rapidity with which currents may be made to succeed each other; the one most generally employed is to discharge the near end of the line immediately after it is disconnected from the battery, before another current is sent into it." Other methods also have been adopted to answer the same end, as urging the return of a plus current by soliciting it into some minus receptacle offered to it in place of the earth; but the necessity for these or other similar contrivances is avoided in our system by having no return current to wait for.

273. We will enumerate the principal features of a submarine telegraph, such as our theory suggests as being calculated for good service; and it will, by a little investigation, be seen that the improvements we have in view are all mainly founded upon the avoidance of those high intensities of electrical action that have generally been regarded as necessary, but at the same time as evils. We cannot see them to be necessary, or in any point of view even useful; if our 5th law be a true deduction, all that intensity can possibly do in forwarding a signal is to increase the quantity of electricity truly conducted along the telegraphic wire in a given time, and this it does, not by accelerating speed, but by increasing the breadth or density of the current which it accomplishes only in a very slow proportion; to get in this way a double quantity of electricity in the truly conducted current the intensity at the source must be as $1+3=4$, for a treble quantity $1+3+5=9$, and so on, each successive quantity being the product of an intensity increasing as the odd numbers. But we may by other means augment to any extent the quantity of electricity in a voltaic current in the absence of all measurable intensity.

274. In the first place, as charge with its consequent induction is to be always absent from our cable, its conducting wire may be of a sectional area, so large as to transmit by true conduction very large quantities of electricity; for this purpose it should be, if of copper, equivalent to about 3-16ths, or a quarter of an inch in diameter. To prevent its contact with the conducting water, it should be inclosed in a sheathing of suitable insulating material, put on as usual in different layers, which together need not exceed an eighth of an inch in thickness, inasmuch as induction through its substance on conducting matter beyond has not to be provided against. For the preservation of the insulator it should have an outside covering; but into its mechanical qualifications we will not now enter, being occupied solely with the requirements of the cable in an electrical point of view.

275. Both extremities of the conductor should be put into communication with voltaic combinations of large dimensions feebly excited, one of them supplying to it, and the other receiving from it, electricity as rapidly as it can be conveyed along the line simply by the true conducting action, without aid from suffusive conduction, and urged only by the lowest possible amount of electro-motive intensity. The retardation, or inertia, would then be simply as the length of the conductor multiplied into the sectional area of the current of electricity passing along it, while the motive force would be twofold; impulsion at one extremity, and solicitation at the other, thereby, in effect, doubling the speed otherwise obtainable with such an arrangement, which is equal to halving the distance. The free ends of both the voltaic combinations being permanently put to earth, the electricity would be supplied from it to one of them, and received by it from the other, exactly at that rate which the electro-motive apparatus demanded, or could get along the conductor, without sensible or injurious static charge.

276. The conducting wire should nowhere be contracted in diameter, not even in its formation into galvanometers for the indicating instruments, one of which would be in connection at each extremity of the line, so that by breaking and renewing battery contact at either a signal would be readable at the other, although the current might be maintained uniformly in only one direction.

277. A telegraphic conductor thus circumstanced would never have within it more or less electricity than its normal quantity; whether it was under the influence of a plus or a minus source, or if sources of the opposite character acted one at each of its extremities at the same time, parts of its normal electricity would pass from particle to particle simultaneously throughout its whole

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length, the current stopping immediately upon breaking contact, recommencing so soon as the contact was again re-established, but without at any time, whether in action or at rest, the conductor being either under or over charged. Hence it would be always most sensitive to the feeblest electrical impulse, and in a condition to make that impulse immediately known.

278. The Government Submarine Telegraph Committee has reported that "The most important problem to solve in submarine telegraphy undoubtedly is, how the signals may be made to follow each other with the greatest rapidity; and this resolves itself into two questions, how far can the circumstances upon which inductive action depends be removed, and what are the best means to lead away or destroy the residual charge of the wire after the original current has ceased to act." We have now shown that the circumstances upon which the inductive action depends can be removed *in toto*, and consequently, that no means remain necessary for leading away or destroying residual charge. And further, since it is as the report continues to say, "generally admitted by experimentalists that the rapidity of succession of the signals is not affected by varying the number of elements of the battery," which, it will be remembered, we have also deducted from our views of causation, we have in our plan for establishing electrical telegraphy in general, and ocean telegraphy in particular, lost nothing, while we have gained everything, by the suppression of intensity. We are in a position to avail ourselves to the utmost of that velocity in the speed of electricity, which, if it fall much short of the quarter of a million of miles in a minute once imputed to it, is certainly great enough to exceed all our practical requirements.

279. And now, can anyone believe that any views of originating causation which were not discovery, but only mere invention, could have led us to so perfect and general a correspondence with the results of experience as we have just obtained by following our views into this new branch of the universal science of electricity? Surely a system that can do so much in every direction to which it is applied cannot be artificial; and if not, it must claim, and will surely reward, investigation.

280. In concluding for the present let us offer a brief recapitulation of the principles of electrical action that would be involved in the proposed system of electro-telegraphy. We say,—

281. Firstly, that a conducting wire in its natural state has always in possession the precise quantity of electricity that it attracts, and cannot act as a conductor to transmit accumulated electricity until it be itself acted upon inductively by that accumulation in a manner that shall conduce to the reduction of the existing intensity; and which can only be in one of two ways, namely, by affording it lodgment on its own surface by reason of charging capacity conferred by its surroundings, or by transferring either it, or an equal quantity of its own electricity, to some other conductor capable of affording it still better accommodation—that is, under a still lower intensity. And that the production of one or the other of these cases can be determined at pleasure, simply by establishing the conditions for lesser intensity immediately around the conductor, or in connection with its distant extremity.

282. Secondly, that speed along a conductor is not accelerated by augmenting either the intensity or the quantity of electricity; the velocity of transmission through any given conductor being always constant.

283. Thirdly, that the quantity of electricity susceptible of being passed by any point in a conducting wire of given nature and length increases in the simple ratio of its sectional area—assumed to be uniform; and that as the length varies so does also the conduction in simple inverse proportion, by reason of the inertia of electricity to motion being in simple direct proportion.

284. Fourthly, that when the number and nature of the elements in series of a voltaic source are constant the quantity of electricity that it can, in a given time, pour into, or receive from, a wire of adequate nature and diameter increases with their dimensions. That when the dimensions are constant the intensity of electricity is greater when the series is more numerous; and that when both the size and the number are constant the quantity of electricity delivered over in a given time is greater as the conduction through the Voltaic apparatus is made more perfect, either by diminishing the length of the imperfect humid conductor, or improving its conductivity.

285. Fifthly, that a long conducting wire, communicating at one of its extremities with any other good conducting substance constantly in a minus electrical condition, will furnish electricity to it without becoming itself negatively charged, so long as it receives and can freely conduct it; on the other hand, the wire thus in action as a conductor, if it have at one extremity a good conducting substance constantly maintained in a plus electrical condition, will receive electricity from it without becoming itself positive, so long as it can freely conduct, and freely pour, the current into a minus source at the other end of the wire.

286. Sixthly, the article immediately preceding assumes that the wire is in nature, and of a size, that together capacitate it to conduct quite all the electricity that is furnished to one of its ends, and required at the other; and when that is the case it becomes of no importance whether the electricity *in transitu* have been furnished at a higher or a lower intensity, the wire never having in it more electricity than its normal quantity, and consequently no intensity whatever.

287. Seventhly, that the nature and diameter of the wire being constant, the quantity of electricity furnished to it at one end, and required from it at the other, must be less in simple proportion as the length of the wire is greater, because of the diminished speed from inertia consequent upon the greater length. Or, if the quantity of the electricity to be conducted is required to be constant, then the sectional area of the wire must be increased in the same proportion as its length. In this way retardation is kept down to a minimum, and would be so, even in cases of the greatest needful lengths, without any very great augmentation in the diameter of a conductor; because, by virtue of the two electromotive powers including the line between them, it is in the instance of a wire of given conductivity in effect reduced to one half.

288. Eighthly, that the action of a current of electricity upon a galvanometer depends upon the quantity of electricity passing through its coil, and not upon the intensity of the source which has dispatched it, nor of that which may be receiving it.

289. Ninthly, that the galvanometer coils should be made of wire equal in conductivity to that of the wire that puts them in communication with one another, equal facility of conduction being required all through; if, therefore, all the wires be of copper wire they should all have the same diameter.

290. We propose in our next paper further to elucidate these principles by more minutely examining the subjects of *retardation* and *resistances*.

(To be continued.)

TELEGRAPHIC JURORS FOR THE INTERNATIONAL EXHIBITION.

AMONG the many distinguished names on the list of jurors under Class XIII of the International Exhibition, we can observe but few which have in any way been connected with telegraphy, and more especially with ocean telegraphy. Moreover, in regard to this important branch of electrical science, we cannot congratulate the Commissioners upon the choice of representatives which they have been enabled to make. This choice has been productive of some amount of dissatisfaction among an important section of the contributors to Class XIII, and we may therefore venture to point out the necessity of improving the same by a more extended selection among those who have become more or less identified with telegraphic progress. We are quite ready to admit that the few names included in the present selection, however objec-

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sionable in their collective capacity, are by no means so from any individual deficiency of knowledge or experience. But there is another objection which the Commissioners for the International Exhibition appear unaccountably to have overlooked. It is scarcely fair to telegraphic exhibitors, or to telegraphic patentees in general, to select one or two among their number to decide upon the respective merits of the articles exhibited. Could the International Commissioners possibly be aware, for instance, of the peculiar and difficult position in which Professor Wheatstone must be placed, in being called upon to decide as a juror upon the value of his own patented instruments, and of those of Henley, Allan, and Wylde, respectively? Are they ignorant of all the vexed questions of litigation and dispute which make their choice in this instance somewhat of an *inconvenence?* Again, we believe that Professor W. Thomson, who is also a juror under Class XIII, and whose extensive acquirements render him in most points of view eminently fitted for this office, is, conjointly with Mr. Fleeming Jenkin, the patentee of improved instruments for telegraphic transmission. Under these circumstances, and in the absence of a more extended selection of authorities, the nomination of Mr. Fleeming Jenkin as assistant juror for the special department of telegraphy, is certainly calculated to give rise to a dissatisfaction which already, from many quarters, has been expressed.

The absence from the list of referees upon telegraphic matters of such names as those of E. Clark, W. Fairbairn, Sir C. Bright, C. F. Varley, W. Preece, G. Saward, S. Canning, and W. H. Woodhouse, is to be regretted, and is not in all cases to be accounted for.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 53.]

I will now attempt to trace, according to the reading I have adopted of the principles of electrical accumulation, the action which takes place in a few cases of assumed experiments, which are, however, familiar in some form or other to most electricians, and in which the distribution, redistribution, and neutralization (or in fact discharge), are the prominent features of the action.

In order to render some parts of these explanations intelligible, it is necessary to allude to some means of detecting whether a surface is more or less charged. The subject of electrometers will be found discussed more fully further on, but for the present it is sufficient if it be understood that if a piece of gold leaf, or a pith ball, be attached to a perpendicular conducting surface, so that it hangs freely, if that surface becomes charged the gold leaf will stand out at a greater or less angle, being attracted towards some oppositely electrified surface, without which the electrical state of the leaf and surface to which it is attached could not take place.

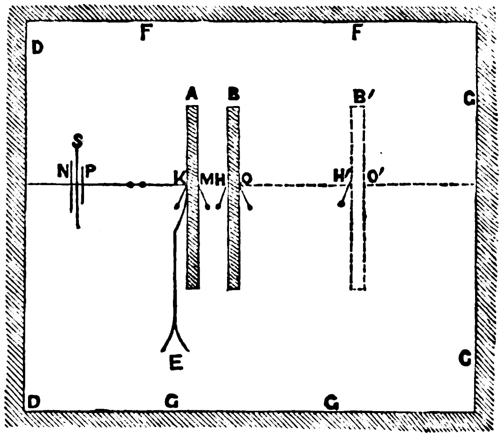
The divergence of the leaf will therefore indicate the presence of electricity; and in the same way two pieces of gold leaf hung from the same point will diverge, indicating electricity on their outer surfaces. If the surrounding surface is kept at the same distance, the greater divergence in either of these cases will indicate a greater quantity of electricity, in the first case on the leaf and charged surface, in the second on the two leaves.

Furthermore, in such problems of redistribution it is evident that when connecting wires are used to cause an alteration in the distribution, the wires themselves must, strictly speaking, form surfaces on which some amount of electricity will be distributed in every case, as long as any electricity remains. It would be perfectly possible to trace out the action even to the distribution on these, but such a minute investigation would lead to an endless amount of detailed description without any corresponding benefit. It must therefore be understood that although in reality these connecting wires form surfaces which are more or less charged, according to the conditions of the case, they may still in practice be so small that the quantity on their surface bears scarcely any proportion to that on those surfaces which form the principal elements in the problem. And indeed as we are dealing with the distribution of electricity only when equilibrium has been entirely re-established, after any change of conditions, without any regard to the time it would take to bring about this state, it is clear we may in theory imagine connecting wires of an indefinitely small section, since if they will conduct to some extent, however minute, equilibrium must, at some period, be re-established. In fact we may imagine a theoretical means of conduction *without a surface.*

With this understanding let us first examine and trace the action which takes place in some of the ordinary experiments with a pair of condensing plates and an electroscope.

Let S (fig. 66), be the source, having its negative pole to the surrounding objects, and its positive pole to the plate A, and

Fig. 66.



electroscope E. Then an inductive circuit will be formed which may be thus traced; from P to the plate A and electroscope E, and from the surface of these to the surrounding objects which are in conductive connection with the negative pole of the source. Indeed it will be convenient to consider the electroscope E and plate A, as situated in two separate branches of the circuit, one branch being from the plate A to surrounding objects, the other from the electroscope to surrounding objects. A certain quantity of positive electricity, dependent on the resistance of the two branches of the circuit will be generated and distributed on the surface of A and the electroscope, in the inverse ratio to the inductive resistance separating each from the surrounding objects, on which an equal quantity of negative will be distributed simultaneously from the negative pole of the source. The outer side of the leaves of the electroscope E, being therefore attracted towards the oppositely charged surrounding objects, the leaves will consequently diverge, and for the same reason the electroscopes at K and M will stand out from the plate A.

Let the source be withdrawn and no alteration will take place in the distribution. If now an insulated plate, B, be approached to A, it will become polarized in its thickness, its side nearest to A, or H, becoming negative, and its outer side, O, positive. The inductive resistance in the direction A C, is slightly decreased by a resistance of a length equal to the thickness of the plate B, and of a sectional area equal to the surface of the plate. Redistribution will therefore take place, a certain small portion of the charge on the K surface of A, and on the electroscope, passing to the surface M, the electroscopes at E and K indicating this loss by a slight decrease in divergence, corresponding redistribution taking place in the opposing negative electricity on the surrounding surface, D, F, C, G.

Let B be now connected to the surrounding surface. Then the positive electricity on its outer surface O will recombine with

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and neutralize, an equal quantity of negative on the surrounding objects. But the quantity of negative on the inner side (H) of B is exactly equal to this quantity of negative annulled, so that the total quantity of negative on B and the other surrounding objects is still exactly equal to the total positive on A, and is the same as before B was placed in position. But this is not all that will take place, for B now forms a part of the surrounding objects, and the inductive resistance being much less between the surfaces M and H than between M and the surface C C, a fresh distribution will take place, according to these new resistances, separating the positively charged surfaces of the plate A and the electroscope E from the negatively charged surrounding surfaces. The accumulation on the surface (M) of A, next to B, will be greatly increased; a decrease taking place on all the other surfaces of A, and on the electroscope E. This change will be indicated by the complete fall of the electroscope at O, the increased divergence of those at M and H, and the decrease of those at K and E.

If now the source be again applied, then since the total resistance of the circuit has been decreased, the total quantity generated will be greater, and a fresh flow from the source will occur both from the positive pole to A, and from the negative pole to the surrounding surface.

Now, if we consider the plate A as a surface in one branch of the circuit, and the electroscope E as a surface in another parallel branch, then from what has already been shown with regard to branch circuits having no common resistance, the quantity on the electroscope E will become exactly the same as that which existed on it before the resistance of the other branch was reduced, by the plate B being placed in its position, and connected to the surrounding objects. The electroscope E will therefore resume its first divergence. The electroscope at K for similar reasons will resume a divergence the same as before.

Now the total resistance of the whole circuit is less than before B was placed and put in contact with C, and the total quantity generated is therefore increased in the same proportion; but this is divided between the surface M and those of K and the electroscope E in the inverse ratio to the inductive resistance, separating those surfaces from the surrounding surface; the first quantity generated was divided after B was in place and connected to C C, in the same proportion; and therefore M's share of the increased total quantity, must be greater than its share of the previous smaller total quantity due to the same proportionate division. This increase on M and H will therefore be indicated by the increased divergence of their electroscopes.

Let the source be now withdrawn, no effect will be produced.

Let now the plate B be removed to B′, being kept in connection with the surrounding objects; then the inductive resistance between A in the direction of B will be increased, all the other resistances remaining unaltered. A fresh distribution of the electricity produced will therefore take place in accordance with these new resistances, which now separate the two opposing surfaces. A certain quantity will therefore pass from the M surface of A to its other surface K, and to the electroscope E, which will be indicated by the decreased divergence of the electroscope M, and the increased divergence of those at K and E. At the same time a corresponding change will take place in the distribution of the negative electricity, a portion passing from the surface H′ to the surfaces D, F, and G, the loss on H′ being indicated by the decreased divergence of its electroscope.

If B′ be removed still further from A to C, these effects on the electroscopes will be increased; and when the plate B is removed to whatever situation it occupied previous to its being placed close to A, the total increased quantity will be distributed in the same proportion on the surfaces as the first quantity produced when the source was first connected to A; the increase of quantity on any one part will therefore be a measure of the proportionate increase on the whole. If the electroscope E be so arranged as to give indications proportionate to the quantity on it, the ratio of the total quantity accumulated when the plate B was placed at B, to that which was obtained without B, can therefore be measured.

We have thus traced the action which takes place in a condenser attached to an electroscope, without any recourse to the earth as "a common reservoir," and without any electricity being "allowed to escape to earth, which it had a tendency to do in virtue of its expansive force;" the whole action consisting partly of a redistribution of the electricity in accordance with the resistances separating the equal and opposite charges in different directions, and partly to *neutralization by the recombination of equal quantities of opposing electricity.*

Let us now suppose the plate B before being withdrawn from its position close to A is first insulated, and let us trace the action that ensues when it is then withdrawn. Now on removing the connection between B and C, we open a fresh indirect inductive circuit between B and A, which may be thus traced: from the surface of B to the surface C C of the surrounding surfaces, and from D D of the common surrounding surface to the surface K of A. The surrounding objects become therefore, as regards conductors A and B, an intermediate conductor, having a common opposing surface D F G C.* In this state no alteration will take place in the distribution by the insertion of the inductive resistance O C. Because that resistance is introduced between two surfaces which are not in any electrical state to one another, whilst none of the other resistances are altered. The surface of O and C will therefore remain neutral. If now B be moved to B′, then the resistance between M and H is increased, whilst that between O and C is decreased. Or, in fact, the resistance to the direct inductive action between A and B is increased, whilst the resistance to the indirect action is decreased. Redistribution will therefore take place. Some of the negative on the H side of B will pass to the O side, rendering this O side negative; C C will become positive, rendering again D D more negative, and at the same time this will be opposed by an increase of positive on the K side of A, some of the positive passing from the M side of A to the K side.

Whatever quantity therefore of negative opposing the total positive charge on A is diverted from the H side of B to the O side is replaced by the increase of the negative on D D; thus leaving the total positive on A opposed by an equal quantity of negative, some of which is on the surrounding surface F D G, and some of which is on B. As B is further removed, the direct action between A and B will be still more reduced, more of negative on B will pass to the O side, making C C more positive, and F D G more negative; at the same time that the positive on A will in like manner redistribute itself in opposition to the increased negative on the surrounding surface F D G.

As B recedes from A the quantity of positive on C C will therefore constantly approach more nearly to the total quantity of negative on B, but will never entirely be equal to it until all direct action between B and A ceases; and in the same manner the total quantity of negative on the surrounding surface F D G, opposing the positive on A, will constantly approach more nearly to the total positive on A, but will never equal it until all direct action between A and B ceases. If, however, B is entirely separated from A by the common surrounding matter, as for instance, if B be carried into another room C′ C′ (fig. 67), then the circuit will have become indirect only, and the quantity of positive induced on the surface C′ C′, surrounding B, will be exactly equal to the total negative on B; but this positive on C′ C′ must of necessity produce its equal quantity of negative on the other surface D F G C, of the common intermediate conductor Z Z Z, thus making the total of negative on that surface exactly equal to the total quantity which existed on it, and on B, before B was removed from its primary position near A, and which total quantity was equal to the total positive on A.

* See also Fig. 15.

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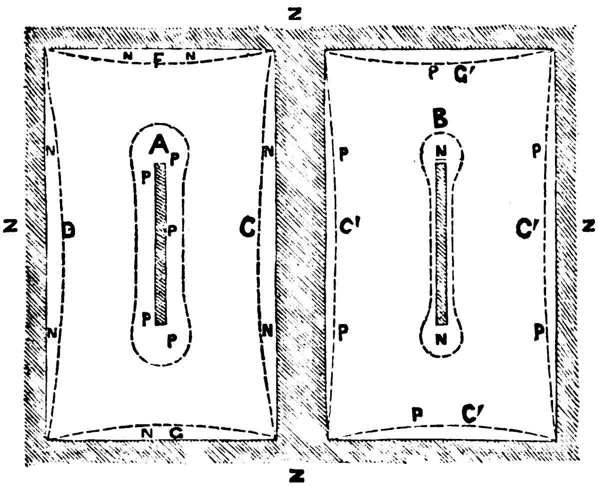
Now when B was at its first position, the total quantity generated consisted of the positive charge on A, and an equal quantity of negative distributed from the negative pole on the surrounding

Fig. 67.



surface; some of this negative quantity had passed to the conductor B, and when B was insulated and removed entirely from A, this charge of negative was carried away with it. If this described the whole action, the quantity of negative on the surface surrounding A would no longer be equal to the positive charge on A; but it has been shown that as B is removed entirely from A, the quantity of positive electricity induced on that surface of the common intermediate conductor surrounding B is exactly equal to the negative charge of B, and that this again must have its equal and opposite quantity on the other surface, D F C C, of the common intermediate conductor, so that the quantity of negative which has been subtracted by B from the surface D F G C surrounding A has been, as it were, replaced by an equal quantity produced through the action in the indirect circuit, thus leaving the total quantity of negative opposing A exactly equal to the positive charge on A.

The quantity on B is less than that on A, however close B may have been at first placed to A, for, we have seen that its charge consisted only of a *part* of the total negative on the surrounding objects, the *whole* of which was only equal to the charge on A.

If when A and B are entirely separated, (as at fig. 67), either of them be connected to the surrounding objects, then the quantity on the surrounding objects being exactly equal and opposite to their charge, these two equal and opposite quantities will neutralize each other, producing what is generally termed discharge.

We have here traced the action commonly known as "the charging of a conductor by induction," without any allusion to a flow of electricity to the "indefinitely large surface of the earth."

(*To be continued.*)

ELECTRICAL PROPERTIES OF THE TOURMALINE.

In the year 1717, Lémery described the property possessed by a crystal of tourmaline of attracting light bodies, and repelling the same after contact. At a later period, Epinus established that the properties of tourmaline are due to electricity, and that the two extremities of the same crystal possess always electrical charges of opposite natures. Not content with proving the polarity of tourmaline, he also succeeded in obtaining a spark by approaching, in the dark, a conductor to one of the extremities of a heated tourmaline. About this period (1759) he communicated to the Royal Society of London an important work upon the properties of the tourmaline, in which it is shown that this mineral acquires electrical polarity only when its temperature rises or falls; it was proved, moreover, that, if the polarised tourmaline be broken, each of the fragments will be found to be polarised, and that the two surfaces of fracture represent electrical poles of contrary denomination.

M. Becquerel has published some interesting observations upon the electrical properties of the tourmaline. He has constated the fact, that the mineral is neutral, so long as its temperature remains constant, and that it becomes polarised when rendered warmer or colder. He also proves that, in the same specimen, the disposition of the poles determined by the elevation of temperature is the reverse of that produced by cold. When a tourmaline is heated, its polarity becomes evidenced at a certain temperature, and the position of the poles remains the same, so long as the temperature is rising; as soon as it becomes stationary all polarity disappears. But the instant the crystal begins to grow cooler the electrical properties re-appear, the poles being now reversed, and preserving the new position so long as the effect of cooling is continued. When, again, the temperature becomes stationary, all polarity disappears. The phenomena are not observed at every degree of the thermometer scale; the tourmaline becomes polarised only between certain limits of temperature, above and below which its loses its polar condition and remains unaffected by heat or by cold respectively. M. Becquerel did not succeed in charging a very sensible condenser by means of the polarised tourmaline, whence he concluded that this mineral neither allows of the escape of electricity, nor abstracts the same from surrounding bodies.

Lastly, the properties of the tourmaline have been studied by M. Gaugain, whose work on the subject has thrown much light on the phenomena of the polarisation of this mineral. He first determined the conditions necessary and sufficient to allow the electricity developed in the tourmaline, by a variation of temperature, to communicate a charge to the electroscope.

The following is the description of one of the experiments of M. Gaugain:—"I suspend to two insulating supports the tourmaline to be experimented with, by means of two fine wires of platinum or copper, wound upon the extremities of the crystal; and, after having put one of the wires in communication with an ordinary gold leaf electroscope, *the other wire being connected to earth*, I heat the tourmaline by any convenient means, and then leave it to cool in the air. If the crystal experimented with has been raised to a very high temperature, the gold leaves may remain unaffected for several moments; but, when the temperature of the tourmaline has fallen below a certain limit, they begin to diverge, the divergence gradually increasing until at length the leaves come into contact with the metal rods intended to discharge them. After having lost the electricity they possessed, they, of course, fall to their original position, but soon begin to diverge afresh. This movement continues until the crystal becomes of the surrounding temperature, and the number of discharges effected serves to measure approximatively the quantity of electricity developed under given conditions. If the experiment be repeated *after removing the communication between one of the poles of the tourmaline and the earth*, the gold leaves are not affected; or, if they diverge, the angle of divergence does not exceed 5 or 6 degrees."

Moreover, the nature of the charge communicated to the electroscope is dependent upon the extremity of the crystal, or pole, which is in communication with the instrument.

M. Gaugain assured himself by direct experiment, that the conductivity of the tourmaline crystal, almost *nil* at ordinary temperatures, rapidly increases when the tourmaline is heated. When the temperature is raised sufficiently to destroy all polarity in the crystal, the conductivity of the latter is sufficient instantly to allow the passage to earth of the charge of an electrometer. The latter fact explains the disappearance of the electrical manifestations in the tourmaline when raised to a high degree of heat; for, if we suppose that electricity is then produced by the effect of cooling, it would flow to earth through the crystal itself and the wire connecting it to the ground, instead of becoming accumulated upon the electroscope, and the gold leaves would preserve their initial position.

In the insulated tourmaline the extremities *alone* give appreciable signs of electricity; this is not the case with a crystal connected to earth by one of its extremities. The middle portion of the tourmaline is then also electrised; and upon this median portion the tension is of the same sign as that of the insulated extremity.

M. Gaugain succeeded in charging a condenser by connecting the two plates respectively to the extremities of an insulated tourmaline, while the latter was cooling. The fragments of a crystal gave the same results as the entire crystal. Of these fragments, the longest developed the greater quantity of electricity; and the whole crystal always furnished a greater quantity than any of its fragments when broken. The quantity of electricity developed while the temperature is becoming lowered diminishes, therefore, with the length of the

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crystals employed; or, in other terms, with the number of elements of which it is composed.

It results from these facts, that a crystal of tourmaline, in the process of cooling, behaves as an electromotor; the terminal surfaces of the crystal representing the poles of a battery. The distribution of tensions in the insulated tourmaline, and in the same when connected to earth by one of its extremities, and the influence of its length upon the quantity of electricity supplied, both tend to show that the polarity acquired by the tourmaline is the result of the action of a true electromotive force developed under the influence of variations of temperature.

Perceiving the influence of the length of crystals upon the intensity of the phenomena produced, M. Gaugain associated together several tourmalines. According to one method, the crystals were united in series, *i.e.*, by their contrary poles; in the other method they were disposed as a battery, with the poles of the same sign united. It follows from his experiments, that in every case the tourmaline, in the process of cooling, behaves as a dry pile opposing a very great resistance to the passage of electricity, and capable of supplying in a given time but a comparatively small quantity of free electricity.

Operating with a battery of fifteen tourmalines united by their poles of the same name, M. Gaugain succeeded in communicating to a small coated pane a charge sufficiently powerful to produce a spark from 2 to 3 *millimetres* in length.

M. Gaugain has latterly communicated to the Academy of Sciences two new notes upon the electrical properties of the tourmaline. In this last work he was enabled to obviate all the losses of electricity resulting from the contact of air, and the imperfect insulation of the supports. We thus found that the quantity of electricity developed in a tourmaline undergoing a cooling effect between two given limits of temperature is constant and independent of the rapidity of cooling. From this remarkable result M. Gaugain has deduced the following simple law:—

The mean of the electrical intensity is directly proportionate to the mean rapidity of cooling.

In the same work, M. Gaugain has shown that, contrary to the opinion generally admitted by physicians, the *total quantity* of electricity developed by *heating* is *always equal* to that which is produced in the course of *cooling*, when the variation of temperature in the tourmaline is included between the same limits on the thermometric scale.

The tourmaline does not alone possess the property of becoming polarised under the influence of variations of temperature. According to the researches of Haüy, many of the crystals which constitute exceptions to the law of symmetry acquire opposite polarities at their terminal surfaces while being heated, or in cooling.

GAVARRET, *Traité d'Electricité.*

ALLAN'S DEEP SEA TELEGRAPH CABLE.

IN a late number we announced our intention of giving a description of some of the cables submitted for test under the direction of the late Experimental Committee of the Board of Trade, as a subject of the greatest importance and interest to those who have the real welfare of ocean telegraphy at heart. It is with much pleasure that we this week draw attention to a cable invented by Mr. Allan long previous to the misfortunes that have so seriously impeded our progress in deep sea telegraphy.

In 1853 Mr. Allan first patented his principle of cable, and at that early period pointed out that if ever great depths and long ocean distances were to be successfully accomplished, some system of light but efficient cable must be adopted. Since that date, he has consistently recommended light cables with large conductors thickly insulated, and of light specific gravity, as the effectual means of securing a successful system of ocean telegraphy.

Where the cable is to be laid in shallow water, and rugged shores approached, massive cables are essentially necessary; but in no instance of great depths should the heavy metal-cased cables be submerged. Experience, dearly bought, has proved this to be the correct principle. The merits of light cables, and the utter unfitness of heavy cables, for deep sea purposes, are now universally acknowledged; and we think it but a simple act of justice to give to Mr. Allan the credit of being the first to show the absurdity of heavy deep sea cables, and also at being the first to point out a remedy.

Mr. Allan claims for his principle of deep sea telegraph cable that it combines the maximum of conducting power, insulation, strength, flexibility, and durability, with the minimum of weight, bulk, cost, and risk in submergence. He adopts the solid copper wire as giving the greatest amount of conducting power with the least amount of inductive surface. The strand of copper wire used for the ordinary form of cable presents considerably more surface than would be obtained with the same amount of conductivity in a solid copper wire, but it is found safer to sacrifice a small amount of speed, owing to the increased surface, than to run the risk of a fracture in the solid copper conductor. Having obtained the best soft solid copper wire he surrounds it with small steel wires of the best quality laid on with a slight spiral, and this forms the inextensible core or conductor, and also the strength of the cable. This core, or backbone of the cable, is then insulated with separate layers of gutta percha, or india rubber, or any other combination of the two; but it is Mr. Allan's opinion that none of the failures in deep sea cables ought to injure the reputation of gutta percha as an insulator, and his confidence in its suitability for submarine telegraphy remains unshaken provided it be applied to the conductor with the necessary amount of care, and not submitted to any crushing or stretching process before it reaches its ocean bed. The insulated core is then clothed with a slight covering of hemp, or any other cheap material, saturated with marine paint, and this completes the deep sea cable.

We observe, in reading the Report of the evidence of some of our authorities in submarine telegraphy, given previous to the testing of this cable by the Government Commission, that in some cases they appear quite opposed to it both mechanically and electrically; upon testing, however, the results gave a decided negative to the objections raised. The specimens sent in by Mr. Allan for testing appeared to us to be exceedingly well adapted for deep sea purposes. In all cases they possessed in a high degree the two great essentials—conducting power and insulation.

The true mechanical test of a submarine cable is to ascertain the number of fathoms of its own length it will sustain in water without elongating to any serious extent. If the conductor, or metallic portion of the cable, be small, then the cable may sustain an enormous length of its own weight in water, and still not be at all suited for a long distance because of the insufficiency of conducting power. In this respect Mr. Allan's cables were excellent examples, with a much larger conductor than most of the other light cables sent in for testing. Mr. Allan's bore a weight nearly equal to 7,500 fathoms without elongating one per cent., and this may be taken as the weakest link in the chain, for joins in the steel wires abounded. This cable was also tested round a 12-inch wheel to see if the core would cut through the gutta percha, and although this ordeal was at least ten times more severe than it could be subjected to in submergence, not the slightest deviation from the centre could be detected. The following is the report after the experiments were conducted, (Government Report, page 28). "The results shown in the above table for Mr. Allan's cables are remarkable. In these cables the strength is given by steel wires laid spirally round the copper conductor, thus using the strength-giving material to form part of the conductor; the area of the conductor is therefore increased; and there is no danger of the conductor knuckling through the gutta percha from the resiliency of the latter. This addition to the conducting area increases the induction of the cable in the full ratio of the increased area, but it only increases the conducting power of the cable in the proportion which the conductivity of steel bears to that of copper, which is about one-seventh. To obtain the same capacity for the transmission of messages in a cable of this kind as in a cable in which copper forms the sole conductor, the dimensions of the conductor must be increased to give the same ratio of conduction to induction. The insulating material of course requires protection in these as in other cables." The latter portion of this report we consider scarcely correct. We have now before us a specimen in which the compound conductor has no greater surface than the ordinary copper strand of the same conducting power. We intended giving an illustration of this principle of cable, but it is so few in parts that we can readily convey it to our readers by simply saying that it is composed of a No. 8 soft copper wire surrounded with 25 No. 25 best steel wires, this is insulated with four separate coatings of best gutta percha, and then finished in a skin of hemp merely to protect it during submergence, the conducting power of the cord is equal to 520lbs. of copper, and it is insulated with 550lbs. of gutta percha per nautical mile; in diameter it measures five-eights of an inch, weight per naut. in ship is 13 cwt., with a specific gravity of 1·7, and it is calculated to bear 7,500 fathoms of itself in water without elongating one per cent. Mr. Allan considers this cable suitable for a distance of 2060 nautical miles, and a depth of 3000 fathoms, the shore ends of course to be heavily protected. A cable of this description has the great advantage of being very simple to manufacture, in fact it could be entirely finished by the manufacturer of telegraph cores. There are many instances of the gutta percha core receiving injury during the process of iron wire

covering, which have only been detected after the cable has been submerged.

It is of the greatest importance that submarine cables should be kept and regularly tested in water during manufacture, and also whilst on board ship, without injury to the strength of the cable. After submergence the strength of the cable should remain unimpaired, if possible, so that its recovery, if necessary, would be ensured. In both these essentials Mr. Allan's cable excels, the gutta percha affording complete protection to the steel wires, and therefore establishing its durability.

Flexible, light, and low in specific gravity, 2000 miles of this cable could be stowed and successfully submerged from one vessel, although two smaller vessels with each one half would be preferable, as the cable could then be submerged in half the time, which is a consideration where fine weather is not to be depended on for any considerable length of time.

With light cables of small diameter less damage is likely to be done to the core either in submerging to or recovering from great depths. Mr. W. Fairbairn, at the conclusion of his Report to the Government Committee, recommends that the conducting wires should be the strength of the cable, and that it should be from 40 to 50 per cent. heavier than water, and with the insulation and its protecting covering of hemp, or other material, not to exceed half an inch in diameter. We need scarcely add that this is just describing Mr. Allan's prineple of deep sea cable.

If we compare the cable we have described with the one laid by the Atlantic Company in 1858, we have the following results;—Whilst their diameters are equal, both being five-eighths of an inch, the conducting power of Mr. Allan's is to the Atlantic as 520 to 108, and insulating material as 550 to 276, the fathoms supported in water as 7500 to 4000, and weight per naut. as 13 to 23, and even with such marked superiority we doubt if it would exceed the Atlantie in cost, if we estimate the cost per mile by the sum the Atlantic Company paid to manufacture and submerge it. Again, if we contrast Mr. Allan's principle with the cable proposed by Messrs. Glass, Elliott and Co. for a like distance and depth, (described in a late number of our Journal), and which we understand they recommend as the result of their experience in deep sea telegraphy, we find that although the conducting power and insulation is only equal to Mr. Allan's, its diameter is increased to seven-eighths of an inch, the fathoms supported in water only 5000 against 7500, whilst its absolute weight would amount to 35 cwt. per nautical mile.

The expense in shipping in this case would be enormous, and the cost per mile of cable itself would be nearly double the one we have under our notice at present. Moreover, we consider the cable proposed by Messrs. Glass, Elliott and Co. as identical in mechanical principle with the late Atlantic, and just as liable to be destroyed in submerging to great depths from the spiral form in which the strength-giving material is applied, also from its great weight requiring the use of heavy machinery to control the paying out. Mr. Allan has from the first urged the abandonment of heavy deep sea cables, and therefore dispensing with the heavy paying-out gear; in this we entirely agree with him—and as his cable was the first, we believe it still keeps in advance of all other attempts at light deep sea cables. We close this article firmly believing that if light deep sea cables of the principle we have here brought before our readers be adopted, the dark clouds which have so long hung over the efforts of submarine telegraphy will speedily be dissipated, and be the beginning of a new era terminating in the electrical union of the four quarters of the globe.

We understand Mr. Allan guarantees six words per minute through the cable described with the ordinary Morse instrument, and ten words by his improved mode of working; a description of which we intend to give in a future number.

SOME MAGNETIC EXPERIMENTS.

BY B. FINCKE, M.D.

1. *Electro-magnetic Action on the Human Body.*—100 yards of copper-wire, No. 30, covered with cotton and shellac, are coiled upon a wooden frame, and an astatic needle, consisting of two No. 7 sewing needles, magnetized and joined about one inch distance with a piece of wood, is delicately hung up in the open space, left for this purpose, by a silk-fibre seven inches high. Between the upper needle and the wire a dial with circular measure is interposed. The coil is fastened into a square wooden box, and closed with a glass bell against the current of air. The ends of the wire leave the box near its foot, and a handle of sheet zinc is attached to the inner end, another one of sheet copper to the outer end. The instrument is put on an immoveable stand fixed to the wall of the building, and there wire-ends are fastened in such a manner that the grasping of the handles does not disturb the needle. The coil stands continually in the magnetic-meridian, determined by a single needle. The astatic needle takes a more or less equatorial position, the upper north pole usually pointing north-east. No disturbances of this needle have been observed so far, and if any should occur, they can be controlled by another double needle hung up for the purpose of observing magnetic disturbances in another room.

The galvanometer shows the following strength. If the naked ends of the wire half an inch apart are immersed one-eighth of an inch into one drachm of distilled water contained in a flat watch-glass, the upper north pole shows a northern deflection of 2° 30′ from its position north-east. If the inner end of the wire is armed with one sixty-fourth of one grain of zinc, and immersion takes place in the same manner, a northern deflection of 5° follows. If one drop of sulphuric acid is added to the water, and the naked ends are immersed as above, the deflection toward north is 5°, and, if the inner end is armed with zinc, as above, and the ends are immersed as described, the deflection in northern direction amounts to 300°, and generally more. The deflection increases still more, when the upper north pole stands south of the equator, and then is of the southern direction.

The electro-magnetic action of the human body upon this multiplier is shown by the following simple operation. The person to be experimented upon grasps the handles in his hands, and holds them until the maximum of deflection of the needle is reached. The deflection ensues, and varies according to the different personalities and their momentary conditions. Sometimes the needle will not move at all, or very slowly a few degrees, and sometimes a rapid rotation through the whole circle and more ensues. The other day, immediately after having done some handiwork, I got a rotation of four circles.

This experiment promises to become a valuable aid in the estimation of the conducting power of the nervous system, as also in the examination of various secretions and excretions of the human body, objects of importance in physiology, pathology, and therapeutics. And I do use it, in fact, for the purpose of diagnosis.

2. *Magnetic Paradox.*—On operating with the astatic needle in the above-described apparatus, some curious facts were elicited, which seems to demand explanation.

Some cut iron nails, presented with their head or point to a single oscillating magnetic needle, invariably attract either north or south pole. If, however, the heads of such nails are pointed towards the upper north pole of the astatic needle, the north pole is repelled to a quarter of a circle and more. The same occurs whether the single or the double needle first be tried. In fact, those nails prove indifferent to a single needle and polar to a double one. This observation, moreover, is corroborated by testing upon another astatic needle of different size and proportion. The same phenomenon has been observed with other pieces of iron, which I happened to try, such as soft iron-wire, cast iron, cast-iron screws, forged iron, &c.

Curiously enough, I found some other pieces of iron, such as cast-iron nails, sewing needles, watch-springs, and a piece of iron rod, all of which repel the upper north pole of the above-described astatic needle, attract the upper north pole of another one, and equally attract north and south pole of the single needle.

3. *Direct Magnetic Action of the Human Body.*—A gentleman of considerable mesmeric power, single, thirty-two years old, had drawn my attention to this subject, after he had noticed several times and shown to me, that a pair of scissors, he inclosed in his hands for a minute or two, deflected the needle of a delicate pocket-compass visibly more than it had done before.

Nov. 7, 1861.—The same gentleman pointed his right forefinger directly towards the upper north pole of the above-described astatic needle, as near as the covering would admit, without touching it, while, at the same time, I grasped with both my hands his left hand, and thereupon followed a distinct deflection of 50″.

4. *Difference of Momentum between the opposite Poles of Magnetic Needles.*—Before I hit upon the new magnetometer, described in No. 25, vol. v., of the *Scientific American*, I tested small magnetized needles upon a common single rhomboidal needle, by presenting both respective north poles to each other. The deflection of the oscillating needle would give the desired result. On applying then the south poles to one another, it was observed, that the deflection amounted to 20° more than before, at the north pole. Similar observations were made upon the astatic needle, one of which is mentioned above in subject No. 1.

It appeared to me singular, that the south pole should swing further than the north pole, on application of the respective poles of one and the same needle, since, not only the needle is carefully poised on the

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pivot, but also the one end moved, of course, has to carry the opposite end in equal ratio. This leads to the following reasoning:—

The rhomboidal needle is broader in the middle than at both ends. The angle of inclination is by this arrangement diminished and almost neutralized, because the gravitation of the central portion by far surpasses the amount of inclination, so that it escapes direct ocular observation. There is, however, probably, an infinitesimal angle of inclination left, if the needle is correctly poised in the middle, which may account for the difference in momentum. The south pole, therefore, is actually more remote from the centre of rotation by the moment of inclination, and swings round with a corresponding centrifugal force, greater than that of the north pole on application of the soliciting south pole of the testing magnet.

The needle, then, resembles a lever of the first kind, the deflection of which is inversely as the sines of the respectives arcs on application of an equal force upon either pole, and the consequence is, that the momentum of the south pole increases with the angle of inclination of the north pole.—*From the Scientific American.*

MILITARY TELEGRAPH CABLE SUCCESSFULLY LAID.

The submarine telegraph cable was successfully laid on the 19th of May, across the Chesapeake Bay, from Cherry Stone to Back River, in Virginia, and the War Department is now in telegraphic communication with Fortress Monroe and Gen. M'Clellan's head-quarters.

The cable, twenty-five miles in length, is heavily armoured with sixteen stout iron wires, arranged longitudinally, like the staves of a barrel—around the insulating coat and conductor, and protecting them from all strain by any force short of what would be required to break the covering wires, the aggregate strength of which equals that of a ship's chain cable.

The longitudinal wires are hooped by a still heavier wire, wound spirally round them, which binds them together so that they form a strong, but flexible, tube of iron that effectually protects the conductor and the insulating coat. This is deemed a great improvement over the English system of spiral wire armour, which was used in the Atlantic cable, and tended so strongly and incorrigibly to twist and kink.

At the time of laying the first temporary cable, there was no heavy cable in this country, or machinery for its expeditious manufacture. The experiment was made with such cable as could be extemporized at the moment, and which was constructed like the English cable, 370 miles in length, laid in the Black Sea, between Varna and Balaklava, during the Crimean war, and which worked so admirably for several months.

The temporary cable worked successfully, and most opportunely, to relieve the public mind on the memorable Sunday of the battle between the *Monitor* and the *Merrimac*, but in a few days was dragged away by anchors, or otherwise broken—an accident not likely to happen to a cable of such immense strength as the new one.

The present cable was manufactured in New York, under the orders of Col. Anson Stager, Military Superintendent of United States Telegraphs, and was laid in four hours, under the supervision of Mr. Wm. H. Heiss, who also superintended its manufacture. A brake of novel construction was used to govern the paying out of the cable, and worked so admirably that it is thought it will overcome one of the greatest difficulties experienced in laying the Atlantic cable.—*From the Scientific American.*

PRICES CURRENT OF INSULATING MATERIALS.

Gutta Percha.

The stock is now chiefly in the hands of the large manufacturers, who never bring the raw material on the market for sale. Consequently, to execute orders, very high prices will have to be given for the small parcels that are to be obtained.

India Rubber.

The large parcels of Para offered at Liverpool by public sales on the 5th instant were all withdrawn. The trade declined to give the last rates, as the general opinion is that the prices must give way considerably. The stock there of Para is now 430 tons, and 30 tons of Cerea.

Small sales have been made here previous to the 5th, at under 1s. 11d. for fine old dry Para.

Fine Java ... ... 1s. 5d. to 1s. 6d. per lb.

June 12, 1862. Wm. Kirkmann,
4, Horford Buildings, Fenchurch Street, E.C.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	25 to 30	——
20	Do. B 7 per cent. till 1862 .	all	18 to 20	——
20	Do. C. " "	all	9 to 11	——
10	London & S. of Ireland Direct.	2	— —	——
Stock	Electric Telegraph . .	100	100 to 108	——
5	London District Telegraph .	4¾	3¾ to 3¼ dis.	——
10	Mediterranean Extension Tel.	all	3½ to 4½	——
20	Red Sea and India Telegraph	all	18¾ to 19¼	——
1	Submarine Telegraph, scrip.	all	⅜ to ½	——
1	Do. registered . . .	all	⅜ to ½	——
10	Do. " . . .	all	4 to 6	——
2	Telegraph to India . .	1	¼ dis. — par.	——
5	United Kingdom Telegraph .	3	2 to 1 dis.	——

Telegraphic News.

RED SEA AND INDIA TELEGRAPH COMPANY BILL.

The Duke of Argyll, in moving the second reading of this Bill, said that its object was to make the best of a bad bargain. The Government of 1858 had entered into an agreement with a company which had engaged to complete an electric telegraph communication between England and India. By that agreement the company had been guaranteed an annual payment of 4½ per cent. on any sum up to £800,000 which the might expend on the work, provided they succeeded in establishing such a communication. They had accomplished that condition; but very soon after the line had been brought into working order some of the most important of its links had become defective, and had never since been restored. But the Government were still bound to pay the stipulated 4½ per cent. per annum. Under these circumstances the whole operation had become a failure; but a new company had entered into an engagement to re-open the line on the condition that, in the event of their success, they should be allowed an interest to the amount of 25 per cent. on their proposed outlay of £200,000, while they were not to be entitled under any circumstances to any payment out of the national exchequer. To these terms the Government had assented, and the object of the present Bill was to give to them the sanction of an Act of Parliament.

The Earl of Ellenborough said that the establishment of that telegraphic communication was an object of the highest political importance; and it appeared to him that it would be better that it should be undertaken by the Government than be left to a private company, which could hardly carry on its operations without frequent public protection and assistance.

Lord Lyveden wished to know if the Government had considered the question whether the proposed line of communication was the best one that could be established.

The Duke of Argyll said that the arrangement entered into with the company would involve the Government in no kind of liability, and would merely entitle the company to a certain interest on its expenditure.

Lord Lyveden said he thought it was most important that the Government should not enter into any engagement which would prevent the construction of any other line of telegraphic communication between this country and India.

Lord Redesdale said that in his opinion it would be very desirable that the arrangement between the Government and the company should be set forth in a schedule of the Bill.

Earl Grey wished to know, whether under that arrangement, the company would have a monopoly of that line of communication. He thought it most important that the hands of the Government and of Parliament should not be bound by any such engagement.

The Duke of Argyll said he did not understand that any engagement was contracted to the effect that no other line should be established. With regard to the suggestion of the noble lord the chairman of committees (Lord Redesdale), he had to observe that the Treasury Minute containing the proposals of the Government, and the letter of the company containing their acceptance of those proposals, had already been laid before Parliament. But he could have no objection to set forth that arrangement in a schedule of the Bill, if the rules of parliamentary proceeding would admit of their pursuing that course.

Lord Redesdale said he did not think there was much reason to apprehend any competition in the establishment of such a line of communication. His opinion was that the £200,000 proposed to be expended in that case would be thrown away. And, moreover, he was convinced that in the event of a war the communication would be destroyed.

The Bill was then read a second time.

THE ATLANTIC TELEGRAPH.

The paddle-wheel steam surveying vessel *Porcupine*, 3, Master Com-

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mander Hoskyn, at Devonport, appointed on the application of the Directors of the Atlantic Telegraph Company to take soundings in the Atlantic, will be provided with a donkey-engine on deck to assist the men. The machines which will be used are those called the "Bull-dog" machines. They are constructed on the principle best adapted for bringing up portions of the bottom. Brooke's apparatus will also be employed. The *Porcupine*, it is expected, will, in the first place, proceed to that part of the Atlantic where there is what is popularly called a "cliff" in the bed of the ocean, at which point it is supposed the former cable was broken. At the head of this declivity, about 200 miles from Ireland, there is a depth of 550 fathoms, and at the foot 1,750 fathoms, showing a difference of 1,200 fathoms. But this decline extends over a distance of eight miles, so that the fall is only one in eight. Other portions will no doubt be sounded. It is stated that in the event of a second attempt to establish telegraphic communication across the Atlantic, some place on the coast of Ireland, further north than Valentia harbour, will be selected for the purpose of obtaining a more convenient bed for the reception of the wire. The burden of the *Porcupine* being only 282 tons, she is rather small for the duty. The donkey-engine alone will weigh 10 tons, and this, with the fuel necessary to be kept near it on deck, may cause her to roll, especially when her stock of coal is diminished. While employed sounding very little coal will be expended, but as she cannot stow above 100 tons frequent communications with the shore will be necessary. Galway or some other western port in Ireland will be visited for this purpose. Mr. John E. Davis, Master, R.N. (borne on the books of the *Fisgard*), who has had great experience in surveying, and who accompanied Captain Allen Young in the *Fox*, in 1860, to survey the proposed northern route *via* Faroe, Iceland, Greenland, and Labrador, has been appointed by the hydrographer to go in the *Porcupine* for the purpose of aiding the present inquiry.

THE INDIAN TELEGRAPH.

THE Bombay papers just come to hand state that Colonel Stewart has gone to Teheran to induce the Shah to lower his terms for permitting the Indian telegraph to pass through his dominions. It is hardly expected, however, that Stewart will succeed. In the meantime Mr. Walton has been ordered to extend at once the telegraph from Kurachee to Choubar on the Mekran coast. The Beloochees will assist in the extension, and the Khan of Khelat has engaged to protect the line. On some parts of the Mekran coast, the ground where the telegraph posts will be fixed is formed of mud volcanoes, hardened by the sun. In one place the wires will ascend a bluff mountain 800 feet high, and will then be dropped down perpendicularly to the sea to meet the wires at the base of the mountain. Choubar is opposite Muscat, on the Arabian coast. If the telegraph goes through Arabia, the piratical coast of Ed Katif will have to be avoided, and the wild Arabs on the western banks of the Tigris to be bribed to protect the line. The line would cost upwards of a quarter of a million sterling. In 1864 messages could be sent throughout by telegraph to and from India and England *via* Constantinople and Bagdad.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

SIR,—Papers read before the Institution of Civil Engineers and similar eminently learned societies are generally supposed to be something out of the common line—original in some sense of the word, if it only apply to new views of old matters, or the re-application and re-adaptation of things whose sphere of applicability were therefore considered circumscribed—better still, they are not unfrequently satisfactory indications of the advancement of some branch of art, science, or manufacture; hence these papers carry weight with them. Issuing forth to the world under the auspices of societies and institutions, founded, and in part composed of men who have not a little contributed to place this country foremost among the nations of the earth, it is not surprising that the honour of reading one's own composition before them is ardently sought after, and that some of the holdings-forth should be of that novel description characterized more by an antagonism to as yet incontrovertible facts, than as logical explosions of hitherto universally accepted postulates. Ranking high amongst productions of this description is Mr. Siemens' Paper, on which I wish to make a few remarks.

It is some satisfaction to find that this gentleman must perforce testify to those cardinal virtues of caoutchouc—high insulating power, low specific induction, and its capability of resisting high temperatures; but how the fact of its non-capability of being "put upon the wire in a plastic state, by a die process" can be considered a drawback to it is more than I can divine. One thing I understand, viz., that the necessity of putting gutta percha and its compounds on the wire by this "process" constitutes a prolific source of faults and defects, from the fact that you cannot ensure uniform centricity of the conductor; and it is notorious that in these places where the wire has become eccentric, a fault is certain, sooner or later, to be the result; the tendency of that eccentricity of the wire is to become *more* eccentric, until at length it pushes itself through the mere film of coating which on one side envelopes it.

The "lapped india rubber covering" is at all events proof against this sort of defect; the wire *must* be in the centre, and can never diverge from it; and to argue that faults are caused, or that grounds for faults are latent, so to speak, in such a constructed wire, is simply a proof that Mr. Siemens either does not know the art of properly manufacturing such a wire, or that he wishes to give all possible prominence to a peculiar "combination" which he is interested in bringing into use, and of which he claims to be the inventor, and almost the patentee.

Nor do I understand how gutta percha wires are "less liable to receive accidental injuries." It would be satisfactory to be told what sort of "accidental injuries" are referred to; I know of nothing that can injure caoutchouc, but will be doubly injurious to gutta percha. As to the former becoming "sticky and semi-fluid," it argues not the most thorough acquaintance with the gum which is the subject of the author's interested animadversions, and that there are secrets connected with its manipulation of which he is in blissful ignorance. This notion of the deteriorating effects of the atmosphere and light on caoutchouc is fit only to be classed with the ill-luck of being born on a Friday, or the cheering consequences supposed to ensue when a solitary crow flies over your head. Neither the one nor the other have any deleterious effects upon rubber; on the contrary, I know of blocks of that material in its virgin state which have withstood hail, rain, and sunshine, and every imaginable description of atmosphere for years, and yet sustaining no deleterious effects; indeed the specimens are rather improved than otherwise.

Again, the assertion that pure caoutchouc absorbs water to a greater extent than gutta percha is as purely gratuitous as the other statements we have been considering; the most that can be said, with any degree of truth, is, that there is an *apparently* greater surface absorption; but even this facts compel me to abjure as utterly unsubstantiated. In a rejoinder to a correspondent of THE ELECTRICIAN, who, taking up the cudgels against caoutchouc, boldly made the same assertion as the one in question, I took the opportunity of quoting from Mr. Hancock's work on india rubber, an account of an experiment made by the author with an extremely thin bag of that material, filled with water, and hermetically sealed, in order to test whether it were or were not non-absorbent. The result proved that it was not totally impervious to that element, but since it took nearly a quarter of a century for the 12 ounces to evaporate, it proved that for all practical purposes it is a non-absorbent. I challenged that gentleman to produce an instance of gutta percha's non-absorbent qualities equal to this; but the whole argument was shirked, and the "stern logic of facts," hoodwinked by one who professed to deal in nothing else. It would gratify me much to know what Mr. Siemens has to say anent the "stern logic" of a fact which is worth more than all the illusory fictions that theory can invent. The "Father of India Rubber Manufacture" must and will be esteemed the highest authority on everything that appertains to this particular material; and subsequent writers, *pro* and *con*, must "hide their diminished heads" before him, not excepting the eminent doctors and professors, examined before the Joint Committees by Government appointed.

But from these low depths of purely fictitious, pass we on to a still "lower deep"—to a statement in itself so grotesquely fictitious and absurd, as to require no comment at our hands, since however it may be reiterated nobody will ever believe it; you would not believe me, my friend, if I were to say that this stone I throw up would pass off into empty space, and never find a resting place; but to use a homely phrase, a man may as well "go the whole hog," while he is about it. "Its (caoutchouc) gradual dissolution in sea water" is spoken of with a gravity which borders on the ludicrous; and I can almost fancy the satirical smile of incredulity which wrinkled the faces of the Members of the Institution of Civil Engineers while they were listening to it. How glad I should be to know where our author gathered this choice new fact from; surely from the recesses of his own fertile but treacherous imagination. Strange it is that the world should have arrived at its present age before it found out that sea, or any other water, was a solvent of india rubber. But perhaps our poor old planet is lapsing into second childhood; I will enquire of Doctor Cumming.

Of the two, every schoolboy knows that fresh water is more penetrating than salt or sea water, and yet it chances that I know of india rubber specimens which have been kept in both for years, and which not only do not betray symptoms of "dissolution," but are, to all intents and purposes, improved by the submersion, being compact, solid, and impervious. But why need I dwell upon it? If Mr. Hancock's experiment refutes the charge of absorption, it is tenfold more a refutation of this charge of "gradual dissolution," which has not the shadow of a fact wherewith to support itself.

If Mr. Siemens wished to make out a case which should give the appearance of feasibility to the adoption of his bi-covered wires, he certainly has lamentably failed in the attempt; for this part of his paper is a tissue of unwarrantable assumptions. India rubber requires not the assistance of so questionable an ally as gutta percha, to render it a durable and effective insulator; perhaps it may as Mr. Siemens uses it; but in proper and experienced hands, it is a tub that can well stand upon its own

bottom, which is more than can be said of any other gum. This idea reminds me of defending a besieged town with leather, holding a farthing candle to the sun, or attempting to improve the lines of the rainbow.

MOMUS.

"WOFRAM."

To the Editor of THE ELECTRICIAN.

DEAR SIR,—Can you or any of your contributors inform me what the above is. It is found in a few of the mines in this neighbourhood, resembles coal in appearance, but very much heavier. It is, I believe, used as an alloy with silver. Miners call it a metal, but as it is a non-conductor of electricity I assume this to be incorrect. E. F.

[The mineral *wolfram* is probably referred to. This is a tungstate of iron and manganese, sometimes containing silica, which would account for its non-conducting property. It forms the most common source of the metal *tungsten*. Treated with nitro-hydrochloric acid, wolfram furnishes tungstic acid, of which valuable application has lately been made by MM. Versmann and Oppenheim in the manufacture of the tungstate of soda for the preservation of fabrics, and, consequently, of human life, from the effects of fire.—ED. E.]

TEXTS FROM THE BLUE BOOK.—No. 1.

To the Editor of THE ELECTRICIAN.

"That the interposition of cotton thread between the wire and the india rubber coating, as in Hall and Well's preparation, considerably increases the induction, and diminishes the insulation. The induction is augmented, because the cotton thread, which is a bad insulator (?) increases the surface of the conductor, and the insulation is impaired, not only because the insulating coating is diminished by the thickness of the cotton, but probably also in consequence of the greater inductive action."—*Government Report*, page xxii.

SIR,—The volume from which our text is taken I can conscientiously recommend as being the most entertaining Blue Book that ever passed through the presses of Messrs. Eyre and Spottiswoode, "Printers to the Queen's Most Excellent Majesty;" and indeed it will vie in interest with the most popular works of the day, whether in fun, fact, fiction, or fustian. True it labours under the serious disadvantage of appearing in an indigo dress, and as emanating from publishers who are principally engaged in issuing ponderous volumes of prussian blue, which nobody ever reads, or could read if they felt disposed—and perhaps they were never intended for that purpose, until a decade of centuries has elapsed, when it is supposed they will be pretty deeply dipped into by the men of the twenty-ninth century, in chronicling the history of their barbarian progenitors, and these will doubtless be produced as specimens thereof.

This, however, is a glorious exception to the general run of Blue Books, and falsifies the notion that no good (readable) thing can come out of this Nazareth. Yet, notwithstanding all this laudation, you are not to suppose that it is the embodiment of absolute truth in the particular matters to which it refers; oh dear no! At best it is but an approximation, and as such is of course a most valuable compilation, as containing the quintessence of all that was then known upon the subject, which in truth is a great deal more than was supposed to be known. Absolute truth? I should think not indeed; the statement contained in the above quotation I hold to be purely hypothetical; and so also are other portions which I reserve for future examination. It is, in fact, its fallibility which constitutes one of its chief attractions, as seen, for instance, in the extraordinary disparity of opinions manifested and avowed therein by electrical and telegraphic big-wigs, and also in statements made by some of the examinees, which are doubly entertaining from the fact of their being decidedly *outré:* how, therefore, could the patient gentlemen who formed the Committee be otherwise than fallible, and speak hesitatingly in their Report, lest the opinion they should hazard prove wide of the mark, seeing that the mass of complications was quite sufficient to bewilder them? Their task was no less arduous than that of the unenvied triumvirate who undertook to decide which one out the six hundred who scaled Parnassus, in celebration of the immortal ploughboy, soared nearest to the summit of the sacred mount. The thanks of the nation are due to these gentlemen for the results of their labours, as embodied in the Report, drawn up as it is in language clear, concise, and comprehensive—as faithful a statement of the whole case as it is possible for long-suffering mortals to make out, and truthful withal, considering the data upon which it is grounded. Nevertheless, we propose to subject certain portions thereof to certain critical analysis, and if they be found not in accordance with facts, why then THE ELECTRICIAN will do us the favour to place it upon record, and thereby become itself, what it undoubtedly is in many respects, an advanced text-book.

The appearance of this twenty shillings' worth of electrical and telegraphic experience and information (with guesses to boot), was looked forward to with considerable impatience by a no small portion of the scientific and mercantile world, as well as by a large mass of thinking men up and down the country who belong to neither of these classes. Seeing it was to solve the problem of long sea telegraphs, throw a noonday light on electrical matters generally, and regularly wind up the clock of monopoly, jobbery, and incompetency, never to go again; let us devoutly hope all these ends have been accomplished. Of course, telegraph manufacturers were most eager to know how they stood—each one doubtless expected his particular specimens, as compared with his compeers, would "lick creation," after the most approved transatlantic fashion. And of necessity these gentlemen were up sunning themselves in the seventh circle of the beatitudes, or down in the gloomy dumps of limbo, in proportion as the experimental tables proved their specimens defective or otherwise, in respect of the perfections of their insulation, and the less or greater amount of induction.

The gentlemen named in the text should necessarily be in the latter condition according to this, as their specimens showed a high rate of induction, because, saith the text "of the interposition of the cotton thread between the wire and the india rubber coating;" and yet the manufacturers in question repudiated the statement as unfair themselves, and considered it should have been qualified by an explanatory note attached to the experiments showing the smallness of the dielectrics of their samples as compared with all the others; as this was not done, however, by those who computed the experiments, the Committee in drawing up the Report were quite justified in coming to the conclusion as contained in the text; but it is manifestly erroneous, for the simple reason that the premises are so; I presume they were not made acquainted with the whole of the facts, hence a statement was made which recent experiments controvert; nor were they to blame, they could come to no other conclusion, and this is one illustration of their extreme fallibility, consequent on the incompleteness of the data; if, however, they were cognizant of the disparity alluded to, I cannot but look upon the statement as an aggravated specimen of jumping at conclusions, or they would certainly have qualified it by such an explanation as the circumstances imperatively demanded.

In the Experimental Tables Messrs. Silver's samples show but a very small inductive discharge, and certainly it does appear, to the uninitiated, most extraordinary that one manufacturer of caoutchouc insulated wires should have arrived at such perfection in this respect and the other fall so far below the mark. The impression this was likely to make upon mere superficial readers was unmistakeable. For want of a proper ventilation of the subject, the layer of cotton next the wire was inconsiderately denounced, and prejudice necessarily excited against this particular method of insulation; and yet if any one would give themselves the trouble they might find out for themselves that a well-made wire of this description would show no greater amount of induction, than a similar wire in which the cotton thread had been dispensed with, the thickness of the dielectric being the same. I speak of facts founded upon actual experiments when I say that a wire having a layer of cotton between it and the india rubber coating stands up as well on the electrometer as one minus that appendage, indeed I have known them to surpass the latter in the perfectness of their insulation, and their low inductive discharge; the fact is, it is simply a question of good or bad workmanship. To the best of my recollection Messrs. Wells and Hall were at some trouble to eradicate an impression which is doubtless unjustly derogatory of their method of insulation; soon after the "Government Report" made its appearance, I believe they published in the pages of the *Engineer* a mathematically calculated table, purporting to prove that had the dielectrics of their experimental specimens been of the same thickness as Messrs. Silvers and Co. they would have shown as low an inductive discharge: these calculations may or may not have been correct, I was not sufficiently interested in the matter at the time to test them; but I *can* say that the experiments I have made relative to the matter, subsequently, confirm them.

We shall not preach quite in vain, therefore, if we eradicate erroneous notions, especially when the thing thus brought into disrepute is advantageous in other ways. Oxidation is not a necessary consequence of using the rubber next the wire, and ought never to occur, and yet inexperience, or carelessness on the part of the workman may produce that result, whatever the insulating gum may be, but if the cotton thread be "interposed" you are doubly armed against a possible contingency of this sort; while if outward decomposition should ensue (which would be a very remote operation, if it ever occurred, in a well-manufactured wire), this layer of cotton, and the decomposed gum which would adhere, would form an insulation capable of perpetuating its electrical efficiency for years.

The sum and substance of the whole matter is, therefore, that the cotton thread, while it is advantageous in other respects, *does not necessarily increase the induction*, and that this statement, made by the Government Committee, which in a sense, as applied to those particular specimens, is unquestionably truthful, is yet an erroneous dictum for general application. The samples upon which the statement was founded, doubtless owed their high inductive discharge principally to the thinness of the insulating envelope, combined probably with some other unobserved cause which recent improvements in manufacture effectually obviate.

AMICUS.

To the Editor of THE ELECTRICIAN.

SIR,—In your impression of May 16th is a letter signed "Free Trade and no Monopoly," in which your correspondent, after blowing the trumpet of the so-called United Kingdom Electric Telegraph Company, hopes "in

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the interests of justice" that that company's Bill will pass the Commons.

In your impression of the 6th instant is another letter much to the same effect from "T.," a gentleman who states he "took a *walk* along the Finchley Road," and examined the poles and insulation, &c., of the wires of the United Kingdom Electric Telegraph Company, as an "amateur" electrician, and he seems to have been so pleased with the "series" that he extended his walk all the way to Leighton Buzzard, a distance, I believe, of about 40 miles. As both your correspondents state they are not in any way interested in any of the companies we are, of course, bound to believe them.

As two disinterested parties have come forward to state that the "interests of justice" and the interests of the public are concerned in the success of the Bill of the so-called United Kingdom Electric Telegraph Company, I, as a person totally unconnected with any telegraph company, am desirous of stating why I consider they are not.

In the first place, the new United Kingdom Electric Telegraph Company agreed to purchase the Act of Parliament obtained by the company first (and still) bearing that name, and to pay for it; but they took the name of the company granted by the Act, they used the Act to obtain permission to place their poles on the roads, they acted under the powers granted by Parliament to the United Kingdom Electric Telegraph Company properly so-called, and after taking the title, and making every use they could of the Act they refused to pay for it, and repudiated their bargain; not only that, but on May 13th their counsel coolly says, as a justification of the company, in the Court of Queens Bench, that "the company had become the purchasers of a patent right possessed by another company, and that they had erected the electric telegraph posts with the sanction of the local authorities;" of course, the "patent right" alluded to is the Act they agreed to purchase, but now decline, and the "sanction" was obtained by showing the Act to the local authorities, and upon the strength of possessing it.

So far, therefore, as the "interests of justice" are concerned I think they would be met by the company being compelled to complete their purchase of the Act of Parliament of the company whose title they have usurped, and with its powers let them be content.

With reference to the interests of the public; the United Kingdom Electric Telegraph company was started for the purpose of establishing a uniform rate of one shilling per message irrespective of distance, upon the principle of the penny post, and what capital they had was subscribed for upon that understanding; the company, however, now seek to be relieved from this "principle," and to charge what they please. If they find it won't pay at one price they will charge another, and, if necessary, join issue with the other companies, so under any circumstances the public will be just where they are. So much for the interests of the public.

If any of the statements I have put forth are incorrect my informants are wrong, and the public prints at fault, but until uncontradicted upon good authority the case stands as stated.—I am, sir, your obedient servant,

UPRIGHT DEALING.

June 10th, 1862.

THE SOLAR ECLIPSE OF 1860.

To the Editor of THE ELECTRICIAN.

SIR,—Don E. Rodriguez, in a paper published in the "Transactions of the Royal Academy of Madrid," observes, among other phenomena, the electrical and magnetic influences during the eclipse:—

"The magnetic needle underwent no variation, neither during the eclipse, nor at any other period of the day."

The electrical states of the atmosphere were carefully examined; there being on the building, where the observations were made, two lightning conductors, and another in the tower of an adjoining church, Rodriguez made a large electroscope, by isolating one conductor from the earth, and attaching to its lower part two little balls of elder pith, guarded by a glass tube from the influence of the wind; these remained immovable all the day, and so far the atmospheric electricity had no influence on the electroscope, nor did it vary during the eclipse; the other conductors connected with the earth gave no signs of electric currents during the whole day. These observations lead necessarily to the conclusion that the eclipse exerted no influence over the electric state of the atmosphere.

PARTHENON.

To the Editor of THE ELECTRICIAN.

SIR,—Will you oblige me by answering the following questions through your paper.

Does it require the plates of a voltaic battery to be connected for tension or intensity to obtain an electric light, and what is the smallest number of the Student's, Daniell's ordinary battery, or Smee's, that are required to produce a small electric light?

Would not copper leaf, if it was pasted all round the inside of a jar, and a wire electrotyped to it, answer for the copper pole in a Daniell's &c., arrangement, or it might be pasted round a cylinder of wood?

Is there any known process by which copper can be electrotyped on tin? If so, could you inform me of it, as I thought if ordinary tin canisters were electrotyped with copper inside, they would form the containing vessel and copper pole for a Daniell's battery, and be very cheaply made.

Would several pairs of Smee's do, if they were arranged in one trough, without partitions, and connected for intensity as the silver is enveloped in its own zincs?—I remain, your's obediently, R. EDWARDS.

Newcastle-on-Tyne, June, 1862.

[1. The question is a difficult one to answer, as opinions may differ as to what constitutes a "small electric light." With one couple of Daniell or Smee of moderate size, but strongly excited, sparks may be obtained by rubbing together the wires forming the poles of the couple, especially if these be tipped with box-wood charcoal, or gas-carbon. To produce a continuous arc of flame, the intensity must be increased by the union of several similar couples, connected together by their opposite poles. We have employed forty Daniell's cells for this purpose; but less might suffice for an experiment. 2. The copper leaf would answer every purpose. 3. The cyanide of copper should be used in lieu of the sulphate. 4. In arranging a battery for intensity, it is necessary that the exciting fluids of the couples should be separate and insulated from each other.—ED. E.]

Miscellanea.

THE OVERLAND TELEGRAPH TO INDIA.—It is believed that the Persian route of the overland telegraph to India has been definitely abandoned on account of the exorbitant terms which the Shah of Persia has demanded for allowing the telegraph to pass through his dominions, and for guaranteeing its safety. It has been proposed, in order to avoid Persia, to lay down a submarine cable across the mouth of the Persian Gulf, from Chauber to Muscat. Another plan is to carry the wire up the gulf to Kinshia Island, and then cross over to the Arabian coast by means of short cables to the Islands of Surdey, Bomosa, and Sharia, then for the wire to proceed down the Arabian coast from Ras el Khymah, through the towns of Dibbeh, Sohar, and Burkha to Muscat, and from thence direct on to Bagdad.

MOST ADVANTAGEOUS FORM OF MAGNETS.—To ascertain this was the object of a series of experiments by Dr. Lamont, of Munich, an account of which, by himself, appears in the form of a translation sent to the *Philosophical Magazine* by the Astronomer-Royal. Three determinations were required—the magnetic moment, the weight or mass, and the moment of inertia. For this purpose Dr. Lamont procured hardened steel bars of various forms, magnetized them to saturation, and investigated every form by measurement for the above-mentioned determinations. The results are that narrow magnets are more advantageous than broad, thin than thick; and consequently, the most advantageous form is that in which breadth and thickness disappear and the magnet is transformed into a mathematical line—*i. e.*, a so-called linear magnet—an imaginary one. Practically, there are two forms which appear advantageous—the flat contracting to a point from the middle, and the flat prismatic. Details are given of six series of experiments, also tables of results, and engravings of the various forms of magnets employed.

ON ADJUSTING THE NEEDLES OF A GALVANOMETER.—Mr. J. Broughton, in the *Chemical News*, gives the following directions in making or adjusting an astatic galvanometer, the difficulty of magnetising two needles to exactly the same intensity frequently causes the expenditure of much time and trouble, which may be greatly reduced by the following simple method of procedure:—Let the two needles be as nearly as possible of the same dimensions; a piece of watch-spring will make a good pair for a large instrument. Then, after strongly magnetising them, suspend each singly by a piece of fine silk, and producing a definite deflection by means of a magnet, allow the needle to return to rest, counting the number of oscillations it makes in a constant time (say 1½ minutes). The needle that makes the greater number will be the more highly magnetised, and will probably require, as the case may be, a very slight touch with the similar pole of a magnet, in order to reduce its magnetism to the intensity of the other needle, which can be readily managed after one or two trials in the above manner. When the two needles are subsequently superposed with opposed poles, and finally suspended with the lower one between the coil, the pair will be found to retain but little polarity. The needle, whose directive force still preponderates, can then be readily detected, should it not already be determined by the position of the pair —by carefully holding at the distance of about two feet from one end of the pair, and equidistant from each needle, the north pole of a magnet, and noticing whether the two nearest ends are attracted or repelled. Should the former be the case, it will then be the needle whose south pole is nearest the magnet whose magnetism is still in excess, which must be slightly demagnetised by holding for a second the north pole of a magnet at the distance of two or three inches from that of the needle. By proceeding in this manner, and by noticing the deflections produced by a weak current, as that of a single thermo-electric pair, the needles may be quickly rendered astatic, which will be indicated by the extreme slowness of their oscillations, and by their resting equatorially.

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The Electrician.

VOL. II. No. 33.—JUNE 20, 1862.

CONTENTS:

	PAGE		PAGE
Steps to Theory by the Practice of Electricity	73	Glyphography	81
Ozone	74	The Student	82
Some Considerations on the Principles of Electrical Conduction and Accumulation	75	Prices Current of Insulating Materials	82
International Exhibition	77	Telegraph Shares	83
Electric Animals	80	Law Intelligence	83
		Correspondence	83
		Miscellanea	84
		To Correspondents	84

STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 63.]

Electro Telegraphy.

291. RETARDATION is the *bête noire* of the telegraphist; by experience he has learned the full import of the word in its popular sense, for he well knows that the signals borne by his electricity along a conducting wire too often arrive at their destination in a manner that cannot be satisfactory to one who has observed the speed with which electricity can be made to travel. He has watched this retardation, noted the circumstances on which it depends, and even inferred from them the laws of its increase and decline. But with this his successes have ended; and retardation to him, while ignorant of its cause, has remained an unmitigated evil, because under the arrangements suggested by his doctrines its conditions are hardly to be avoided.

292. In the telegraphic practice that would be established under the guidance of our theory, retardation must be reduced quite to dwarfish proportions; as it would result from only that small amount of inertia that electricity opposes to its own true conduction along a metallic wire, and which is so small a hindrance as to be absolutely unworthy of notice. We are made certain of the insignificance of that limited amount of retardation by observing the speed attained by electricity in particular instances, such as those by which Wheatstone, MM. Fizeau et Gounelle, and MM. Guillemin et Burnouf, separately proved that while it does take some sensible time in its transit through the matter of the best conductors, by reason of its inertia, still, in the absence of all impediments excepting those that are immediately due to the nature of electricity itself, and to the substance it is travelling through, the period is so short as not to exceed a second of time for a hundred thousand miles, and therefore for the lesser distances that we desire to work through, say a few hundreds or a few thousands of miles, the time that would be occupied in the mere passage of electricity must be quite inappreciable. If then the rate of signalling were commensurate with the velocity of electricity through a copper wire, or other good conductor, the speed with which signals could be sent off and received, would have no other limit than that imposed upon it by the powers, animal and intellectual, of our human manipulators. Now compare the perfection to be aimed at with our actual attainments in the employment of telegraph cables, and we cannot but be astonished at the immense shortcoming that we perceive in practice.

293. With all that we know of practical retardation before our eyes, how comparatively insignificant is that small amount of it which Wheatstone and the others who have experimented upon the velocity of electricity, detected in their naked wires; and which alone is all that we can assuredly say is inevitable. And how desirable must be any new system of electro-telegraphy that can give us a rational prospect of at once removing that other vast amount by which the most desirable of our undertakings are always marred, and, when projected, set down in the estimation of the public as of questionable success; that can, in short, offer to our acceptance a submerged cable under as favourable conditions as those we have been made familiar with in the case of aërial lines.

294. Such a system is unequivocably offered by our theory, and that theory has never hitherto disappointed us in any branch of electrical science; this general efficiency precludes all misgiving on our part as to the means indicated by it for the avoidance of retardation, and consequently of its capability for placing submarine electro-telegraphy in a position of social and commercial credit of which it has never yet been made worthy. But, however confident we may be of obtaining this as a final acknowledgment, we do not imagine the proposed system will be all at once sufficiently investigated to have its comprehensiveness and conclusiveness truly seen, so as suddenly to supplant that older one of which, however imperfect, we have at least some experience: it will have to go through a probationary trial, that must occupy time, and may be tardily undertaken. "It is only slowly and by degrees that the mind becomes sufficiently embued with these new truths, of which the office is to change the face of a science. We have to consider the familiar appearances under a new aspect; to refer old facts to new principles; and it is not till after some time that the struggle and hesitation which this employment occasions subsides into a tranquil equilibrium." We believe the electrical causation we have been happy enough to discover, might have been traced by any diligent electrician to whom the elementary idea had first occurred; but while we say this we cannot affect to be unconscious of the importance of the discovery that has been made, and, with these acknowledgments we will venture to add, as pertinent to the present consideration, a further quotation from the same learned author of the "History of the Inductive Sciences," written with reference to another branch of physics. "We have seen, in the history of all capital discoveries, how hardly they have made their way, even among the most intelligent and candid philosophers of the antecedent schools; we must, therefore, not expect that the metamorphosis of the theoretical views which is now going on will be effected without some trouble and delay." There are readers of the articles on electrical theory, published in these pages from week to week, who have *followed* our doctrines as they successively appeared, but our course has been somewhat rapid; we would now offer to any hesitants there may be yet among them a suggestion, borrowing it ourselves from Dr. Whewell: "We might personify philosophical theories, and might represent them to ourselves as figures, all pressing eagerly on in the same direction, whom we have to pursue: and it is only in proportion as we ourselves overtake those figures in the race, and pass beyond them, that we are enabled to look back upon their faces; to discern their real aspects, and to catch the true character of their countenances. If our readers will immediately set forward in such a pursuit they may be early in the recognition of electrical truth, and eminently instrumental in its dissemination; and we cannot be too earnest in recommending them to do so. For our own part, what we have to be engaged in is still to go forward, spreading whatever light we can obtain from our doctrines by comparing the deductions of theory with the actual results of observations gathered from experimentalists in general, and from all the manifold branches of the subject, as they successively present themselves for discussion; we have already done this to some extent with reference to the phenomena of the telegraphic wire and its surroundings, both as they at present exist, and also as they might, and probably will, some day be made; but there yet remain a few considerations that require to be added.

295. We know that by far the greater part of the retardation which has been observed in the working of submerged telegraph cables under the present system, has its circumstantial origin in electrical charge of the conducting wire,—in an induction consequent upon that direct charge,—and in another charge set up by

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induction beyond; and also in two discharges,—one a dismissal of the direct charge of the conductor itself, and the other a dismissal of the induced charge of the conducting matter by which the intervening insulator is surrounded. So long ago as the year 1837 Faraday found, during his experiments, that some portions of an electrical charge lying against the surfaces of insulating materials of various kinds were slowly received into their substance, and afterwards given out again upon the withdrawal of the superficial charge; and in 1850 M. Werner Siemens observed these phenonema in the solid insulators of subterranean telegraph wires; but we attach little importance to this motion of electricity as a cause for retardation, the motion being too minute in quantity to add sensibly to the electrical inertia; and we mention the occurrence only because it is sometimes spoken of as a hindrance to telegraphic speed. Without any doubt, however, the chief source of retardation is by common consent to be found in the charges and discharges above-named, and which Mr. Latimer Clark seems to have been the first to observe in 1852.

296. What our doctrines indicate respecting the conditions for retardation is very intelligible: under the influences of the definite electrical attraction of our theory a plus charge communicated to the conductor of a cable must act inductively upon the solid enveloping solid insulator, propagating the action to its exterior surface, from which it is extended to the surrounding conducting matter, actually dismissing from that matter, whether it be water, damp earth, or a metallic casing, some portion of its natural electricity, to act in its turn inductively upon atmospheric air somewhere—that is, wherever it may be found best situated for establishing with the inductive charge an artificial electrical equilibrium as a substitute for the normal quiescent distribution that under the circumstances has been rendered impossible.

297. Now as we have theoretically no other originating cause for retardation in the practice of electro-telegraphy than the inertia to motion of the electricity itself, the retardation observed in every case of electrical signalling must be held to increase as the sums of the number of particles of electricity put into motion, multiplied each by the number of common particles it successively attaches itself to and quits under the impulse, the effect of which is being retarded.

298. Of the naked aërial conductor, which, as we know by experience, is least subject to retardation, theory teaches that, inasmuch as the charging of the wire (speaking electrically, and on the assumption that all the mechanical arrangements are absolutely perfect) is unattended by any actual displacement by induction of the natural electricity of a surrounding dry atmosphere, the sum of the inertia must be a minimum, due only to the ingress and egress, to and from the wire, of the communicated charge; and that sum will not only be greater in the case of buried cables, but also increases as their submersion or interment is more profound (pars. 236, 237).

299. Taking next the extreme case in the opposite direction, namely, the submerged telegraph cable, with its insulator in contact with water or earth, we have the maximum of retardation in practice, and in theory complicated and extensive motions of electricity, each contributing its quota to the sum of the general inertia. In the first place, there are those motions which we have just alluded to as common to the naked aërial line; and, secondly, the motions of electricity actually dismissed by induction from the water surrounding the insulator, both in its passage away and also in its return; two movements that we shall theoretically find to be very important. The charge and discharge of the submerged cable are very dissimilar to the charge and discharge of the Leyden jar, even on the supposition of the latter having the same extension in length as the former; and in that difference exists great part of the cause for the retardation we are inquiring into. In the case of a Leyden jar, standing with its external coating in communication with the earth, the induced charge that leaves that coating while plus electricity is entering by its ball and stem, can establish itself immediately in artificial equilibrium, offered by a vast extent of atmosphere in continguity; and facility of access exists for the prompt return of the retreated electricity on the discharge of the inner coating, supposing it to be made into the earth; for if the distances were short enough, the electricity would be conducted by the earth directly to the minus coating, and if great a second artificial equilibrium might become established in the neighbourhood of the spot where the discharge was effected. But in the case of the cable, the circumstances are not parallel; its wire cannot become charged unless electricity quit the water in contact with its insulator synchronously with the entrance of the charge, and for the external electrity to quit it will have to ascend to the surface of the water, where it can be near to an atmosphere capable of affording it artificial equilibrium. Now with this incessant vibration of electricity between the external surface of the insulator and the surface of a mass of water, perhaps thousands of fathoms in depth, at every charge and discharge of the wire, we must, as can easily be comprehended, have an incessant and large amount of electrical inertia, fatal to the rapid alternation in the electrical conditions of the wire, so absolutely essential to satisfactory signalling.

300. As the facility with which inertia may be overcome varies, of course, in the simple ratio of the force acting to overcome it, it follows that if, when electricity is passing along a given wire under the impulse of a given electrical charge, either plus or minus, communicating with one of the extremities, we call the amount of inertia or retardation ten units; then, by applying a second equal impulse to propel the electricity onward, which we may do of course by causing an equal and opposite electrical charge to communicate with the other extremity of the wire, we shall in effect reduce the inertia or retardation to five units, or the same reduction may be otherwise achieved if, while the passing electricity is being impelled by one charge only, the wire through which it is being conducted be reduced to one half of its length.

301. If this view of retardation be the true one, there is no reason why our electric signals should not succeed each other throughout the longest submerged lines with perfect distinctness, and with almost inappreciable intervals. Our theory tells us that the emission of a signal from the far extremity of a conductor, however long it may be, by what we have called true electrical conduction, is all but synchronous with its entrance at the other extremity, and universal experience with respect to a single signal confirms the deduction. Theory also assures us that the change from rest to motion and from motion to rest, on which rapidity of succession depends, may be impressed upon the electricity in a wire by the very feeblest amount of electrical force, a small period of time only being consumed in overcoming its inertia; and we may soon learn from observation that a voltaic couple at each end of a connecting wire is a competent arrangement for that purpose. And, lastly, let us remark that if a single communication be not enough for the transmission of all our signals, we can suggest modes for separately insulating several wires within the same external casing, and thus provide for all exigencies.

302. From this exposition of the cause of electrical retardation and its conditions, we shall pass in our next to the consideration of electrical resistances, the nature of which we shall be enabled thoroughly to comprehend.

(To be continued.)

OZONE.

Amongst the apparatus exhibited by Messrs. Siemens and Halske under the eastern dome of the International Exhibition building, a small and unpretending contrivance, termed the *ozone generator*, attracted our particular attention. This apparatus, as kindly described to us by Mr. A. Deede, consists merely of a Leyden arrangement of a tubular form, through the interior of which is made to pass a current of air. The two coatings being charged

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by means of a coil machine or otherwise, the air which is impelled through the tube and which comes in contact with the interior coating becomes ozonized under the electrical influence, as may be shown by appropriate tests applied at the issuing orifice of the tube. The arrangement is intended merely as an instrument of scientific research; but we think it may possibly bear the germ of most important practical applications. Our "constant readers" may remember that we have from time to time devoted some attention to the question of atmospheric purification. It might appear that this subject scarcely falls within our peculiar province; but we have some grounds for believing that electrical science has the closest bearing upon the same. The universal purifier of nature is oxygen, in a modified or *allotropic* condition, assumed under electrical influences. To this substance, and also to what appears to be a compound of the same with hydrogen, the name of ozone has been given. DE LA RIVE explains the formation of ozone by the hypothesis that in ordinary oxygen the atoms are combined in groups or molecules, and that electricity, and also certain substances, such as phosphorus, possess the power of breaking up these molecules into separate atoms, whereby the chemical activity of the gaseous body is increased, so that then it possesses the power of oxydizing bodies upon which ordinary oxygen exerts no influence. To this power is due its beneficial action in the economy of nature. In order to comprehend this, it should be borne in mind that fully oxydized carbon—carbonic acid gas, is the principal food of plants; the carbon becoming assimilated by the growing vegetation, and the oxygen evolved for the support of *animal* life. Now the products of animal and vegetable decomposition, and the *excreta* from the lungs and skin, contain compounds of carbon and hydrogen, which are eminently prejudicial to animal life, and which, moreover, appear to be useless for the support of vegetable life, and almost inalterable in an atmosphere free from ozone. When, therefore, ozone is absent from the atmosphere, various impurities, the physiological action of which is in some cases very remarkable, tend to accumulate. Again, the chemical energy of the air we breathe is lessened, and the blood stagnates and becomes predisposed to disease. An immense number of observations establish the fact that epidemic, and other classes of disease, which are prevalent when ozone is absent from the atmosphere, rapidly decrease and disappear when the wind changes, and an ozoniferous current of air sets in. That the air "becomes cleared" by a thunderstorm, is a more familiar fact. Electrical action is without doubt the principal source of ozone in nature. The peculiar odour of ozone is sometimes strongly perceptible for a considerable distance around the spot where the electricity of a flash of lightning has found its way to earth, and the nitric acid which accompanies the rain water falling during a storm, is to be traced to the oxydation of nitrogen by the action of highly concentrated ozone. But the greater portion of atmospheric ozone is probably formed under the influence of electrical induction taking place through the atmosphere. To imitate, when necessary, these natural conditions, in localities where nature, owing to the immense congregation of human beings in the confined atmosphere of cities, is virtually overtasked, is surely an important problem; and for this reason the apparatus we have mentioned appears to us full of interest.

It must be remembered that air strongly impregnated with ozone is injurious, acting upon the animal system more powerfully than pure oxygen gas, or like chlorine gas, which, indirectly, is a powerful oxydizing agent. Ozone has, therefore, sometimes been termed a poison; but it will be seen that the expression is scarcely applicable in its ordinary acceptation. It is evident, however, that in attempting to imitate the natural conditions for atmospheric purification—a task which some may be inclined to follow—the supply of ozone should be so limited, as to allow of a scarcely appreciable excess of this agent beyond the quantity which may be absorbed in the oxydation of the impurities of the air in a partially confined space. A test paper which will indicate the presence of the surplus quantity of ozone may be formed by dipping paper strips into a mixture of solutions of iodide of potassium and of starch. The white test paper becomes blue by the action of ozone, through a reaction which is intelligible when we consider the iodide of potassium, in presence of the elements of water, as a hydriodate of potassa, or a compound of hydriodic acid—iodine and hydrogen, and potassa—potassium and oxygen. The ozone oxydizes the hydrogen, and liberates iodine, which, with starch, forms a blue compound.

Ozone, or rather its compound with hydrogen of the formula HO_3, has been generally produced by the action of phosphorus upon moist air. In this case a portion of the ozone which is formed is expended in the oxydation of the phosphorus itself; and, according to SCHOENBEIN, the phosphorus inflames when the proportion of ozone generated in the air exceeds that of 1 to 1,300. When it is considered that the odour of ozone may be recognized in air containing but 1-500,000th of its volume of this agent, the above may be regarded as a high degree of ozonization. Pure ozone would possess a most intense odour, and most active chemical properties. It would probably afford the solution of a problem of immense importance to agriculture and manufacture—viz.: the direct oxydation of nitrogen to form nitrous and nitric acid. Hitherto, however, the artificial production of ozone has always been attended with certain conditions for its subsequent decomposition, and a point is soon reached in the generating apparatus where the consumption becomes equal to the supply.

The same fact applies to the production of ozone in closed vessels by the disruptive electrical discharge; the decomposing action of the discharge being evidenced when the degree of ozonization has reached a certain limit. The conditions are somewhat different in the formation of ozone by the escape of plus electricity into the atmosphere by means of a pointed wire, and appear to be altogether modified when a portion of atmospheric air, or of oxygen, is repeatedly brought under the influence of a surface charged with plus electricity.

In a sanitary point of view, however, a cheap source of ozone, generating this agent in minute proportion in admixture with the air supplied to human dwellings from the external atmosphere, is the principal desideratum. To have at our disposition a "change of air" without the necessity for a change of locality, sounds more like ingenious fiction than sober fact. But in nine cases out of ten the necessity to the inhabitants of cities of a change of air, is merely the need of escaping from an atmosphere loaded with oxydizable matter, to one in which there exists a surplus of ozone. We possess, it is true, various oxydizing agents of great value, such as Sir W. BURNETT's chloride of zinc, Mr. TENNANT's chloride of lime, and Mr. CONDY's permanganates; but these are by no means as applicable and effectual as Nature's purifier—gaseous ozone. The evolution of chlorine from its compounds is attended with objection; and the oxydizing action of other disinfectants and purifiers is exerted only on that portion of air which comes in contact with the fluid. Bearing in mind that it is easy to retain for a considerable period the electrical charge of a Leyden arrangement, of which one of the coatings is protected from loss by contact with renewed portions of air, it seems probable that those who study atmospheric signs and tokens, may ere long refer daily to the ozonemeter as well as to the barometer, and regulate, when necessary, the supply of ozone by means of the same, as they would that of heat by the thermometer.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 66].

LET now A and B (fig. 68), be two plates, A connected to the positive, and B to the negative poles of a source, S. Then two branch circuits will be formed which may be traced as follows:

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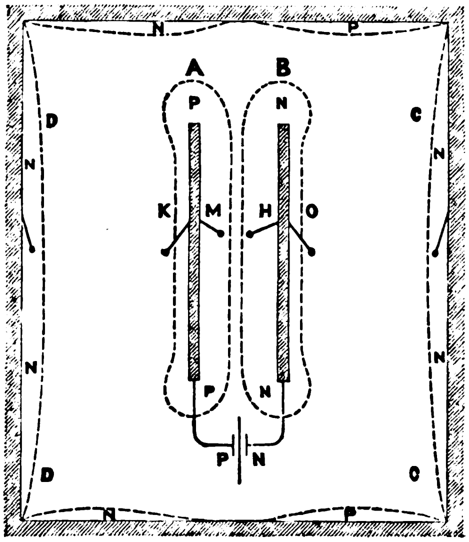
the one direct from the P pole to the interior surface, M, of A, and thence across the dielectric to the interior surface, H, of B,

Fig. 68.

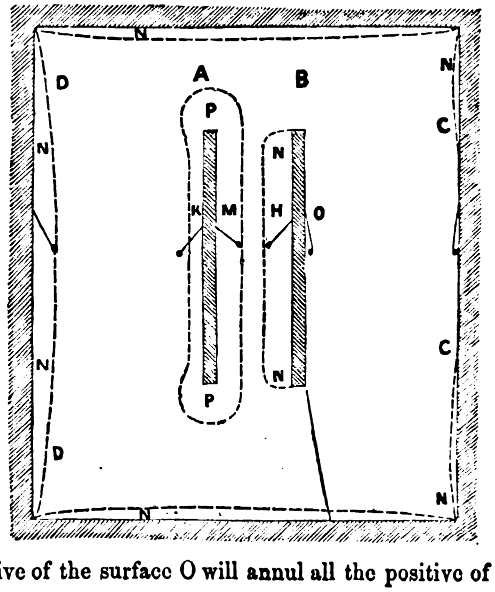


and thence to the N pole; the other indirect from the P pole to the exterior surface, K, of A, thence to the surface D D of the common opposing surrounding surface, and from the surface C C of the same to the exterior surface O of the plate B, and thence to the negative pole of the source.

The quantity on either of the surfaces, M or H, will be to that on K or O, as the resistances K D+O C is to the resistance M H; the closer A and B are situated the greater will be the quantity on the surfaces M and H, as compared to that on K and O. The electroscopes attached to the different surfaces will therefore all diverge. Suppose the plates placed somewhat in the position shown in the figure, then the electroscopes on the surfaces M and H will diverge the most, as the resistance between them is less than the sum of the resistances from the outer surfaces of A and B to the surrounding surface. The electroscopes attached to the outer surfaces will diverge the least as the quantity on the surfaces C C and D D, is only equal to that on the smaller surfaces O and K, and consequently the density is less.

If now the source be withdrawn then all will remain unaltered, Let now B be connected to the surrounding surface (fig. 69), then

Fig. 69.



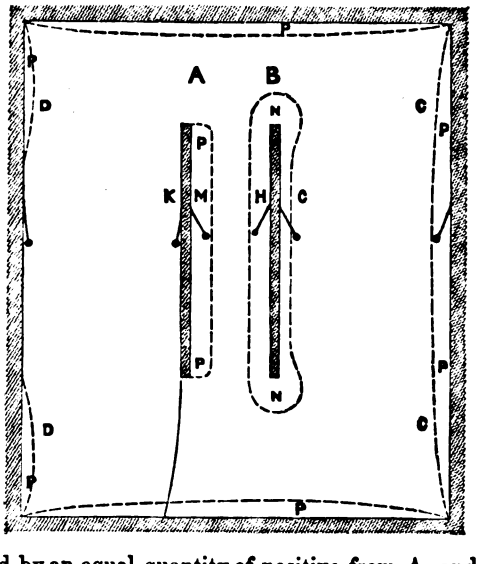
the negative of the surface O will annul all the positive of the surrounding surface C; the electroscopes of O and C will therefore drop. The total negative on B has therefore been reduced by the quantity on O, but this was equal to the positive on C, by which it was annulled, which again was equal to the negative on D D. The quantity of negative on H, together with the negative on D D, will therefore equal the previous total quantity on B, and consequently still be equal to the total positive on A.

Now when B was insulated, the quantity on A divided itself on the surfaces M and K in inverse ratio to the direct and indirect circuits, separating A from B, or the quantity on the surface M was to that on the surface K, as the resistance K D+O C was to the resistance M H.

Now that B is connected to the surrounding objects, the quantity on A will divide itself inversely as the resistances separating its surfaces from B and the other surrounding surfaces. The quantity on M will be to that on K, as the resistance K D is to the resistance M H. The quantity on M will be less, therefore, than it was before B was touched to surrounding objects, and some of the positive on M will, in accordance, pass to the K side, at the same time that some of the remaining negative on B passes to the surface D D. This change will be indicated by the decreased divergence of the electroscopes M and H, and the increase of those at K and D. The total quantity on B is therefore considerably reduced, and the distribution is illustrated by the dotted lines in figure 69.

If now B be insulated no change will take place. Let now A be connected to the surrounding objects (fig. 70), then all the negative on D D and the rest of the surrounding objects will be

Fig. 70.



neutralised by an equal quantity of positive from A, and the electroscopes K and D will fall; the negative on B will now redistribute itself in accordance with the resistances separating its surfaces from A and the other surrounding objects, some of the negative on its surface H will therefore pass to the surface O, whilst an equal quantity of positive will pass from A to the surrounding objects.

The electroscope at O will therefore again diverge strongly, whilst those at M and H will decrease their divergence. Now the quantity on B is all the negative that is left, and this, it has been shown, has been reduced from what it was at first, and is still equal to the total quantity of positive on A and the other surrounding objects. In the same way, if A be again insulated, and B touched to the surrounding objects, all the positive, except that on A, will be annulled by an equal quantity of negative from B, and thus the quantity remaining after each operation will be continually less, but always consist of exactly equal quantities of opposing electricity; but if the insulation was absolutely perfect,

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however often the operation was repeated, the complete discharge of the plates could never be accomplished by this operation of touching them alternately to the surrounding objects. If A and B are both joined at the same time to the surrounding objects, then since the whole of the two equal and opposing quantities are allowed to recombine, complete discharge will ensue.

If after the first charging of the plates A and B from the two poles of the source, and before either is touched to the surrounding objects, they be joined together, complete discharge will ensue; for the equal quantities of opposing electricity will be allowed to recombine at the same time that the equal and opposite induced on D D and C C being likewise free to recombine. But if after the first charging of the plates, one of them be touched to the surrounding objects, and then insulated in the manner already described, then the total quantity on the touched plate we have seen, is no longer equal to the total quantity on the untouched one. If, therefore, the plates be now connected together, the quantities on them being unequal, complete discharge will not ensue; a quantity being left on the plates, which will be exactly equal to the quantity of opposite electricity left on the surrounding objects.

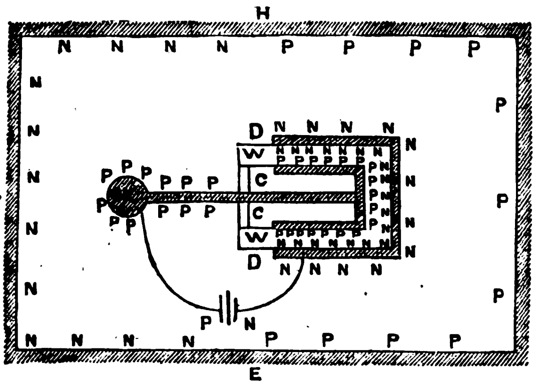
Thus in fig. 69 the positive quantity on A is equal to the sum of the quantities of negative on B, and on the surrounding objects. The quantity on B is less therefore than that on A. If when B is insulated, therefore, it be touched to A, then the negative of B will neutralize an equal quantity of the positive of A, leaving a certain quantity of positive (which will divide itself on the two plates), equal to the previous difference between the charges of A and B; but the negative on the surrounding surface was also equal to this difference between the charges of A and B, and therefore we have still equal quantities of electricity of opposite nature in opposition.

If, whilst the plates are still connected together, they be touched to surrounding objects, then these two equal and opposite quantities will neutralize each other. But if the plates first be disconnected, and then one touched to the surrounding objects, all the positive on that one will be annulled by an equal quantity of negative from the surrounding objects; some of the remaining negative also passing on to the uninsulated plate, and the distribution will again become as shown in fig. 69, only in a less degree, by virtue of the smaller amount of the total quantity left.

The same action may be produced with a Leyden jar, and the same explanation applied, as will easily be understood on reference to figures 41, 42, and 43.

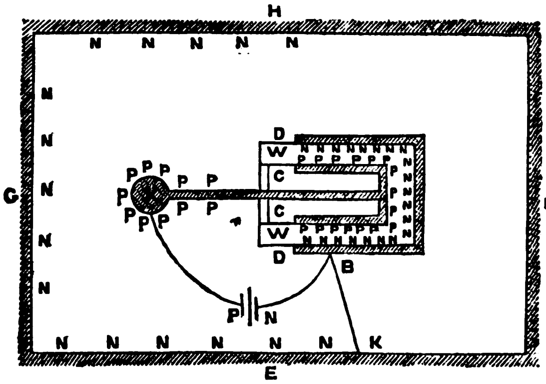
Thus, if an insulated jar be charged from the two poles of a source, as shown in fig. 41, the distribution will be as represented

Fig. 41.



in the figure. If now the source be withdrawn, the distribution will be unaltered; and if the outer coating be connected to the surrounding surface, the quantity of negative on the exterior of the outer coating will be annulled by the equal quantity of positive on the surrounding surface, and some of the negative on the interior of the outer coating will pass to the surface H G E, surrounding the knob K, increasing the quantity of negative there, whilst an equal quantity of positive will leave the interior coating, and pass to the knob K, increasing the quantity on the knob and the distribution that would ensue, is represented in fig. 42. A piece of gold leaf on the outside of the jar would,

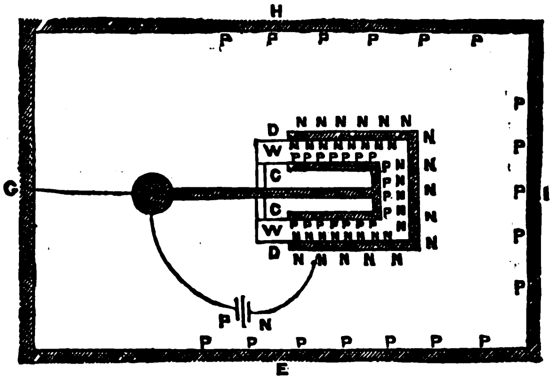
Fig. 42.



therefore, when the jar was first charged, diverge, but on connecting the outer coating to the surrounding objects, would cease to diverge, whilst an electroscope attached to K would increase its divergence. If the outer coating be again insulated, then all will remain the same.

If now the knob K be connected to the surrounding surface, then the quantity on the knob will annul all the negative on the surrounding surface, the electroscope attached to the knob K will therefore cease to diverge; at the same time the quantity of negative on the outer coating will redistribute itself, some of it passing to its exterior surface, whilst an equal quantity of positive will leave the interior coating, and pass to the surrounding objects; the gold leaf on the exterior of the jar will therefore diverge, and the distribution that would ensue is represented in fig. 43.*

Fig. 43.



(*To be continued.*)

International Exhibition.

INVENTIONS SHOWN BY THE BRITISH AND IRISH MAGNETIC TELEGRAPH COMPANY.

Electro-Acoustic Telegraph (Messrs. Brights' Patents of 1852 and 1855).

By this telegraph the operator receiving a message reads off the signals by ear, instead of by the eye as in other telegraphs in use. With the needle telegraphs the receiving operator has to watch each movement of the needle, and after every word the sender must pause to allow the receiver to write it down; a signal is then sent back by the receiver before the sender can forward another word—the speed of transmission being thus comparatively slow. Or when there is a great deal of business, it is customary with the needle telegraph to employ two operators at the receiving

* For the correct illustration of this part of the subject, the source and its connecting wires in figures 42 and 43 should not appear.

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end, one to read off the signals by the eye, and the other to write down the message from his dictation; so that not only is the expense of taking off a message doubled, but from the similarity of sound of many words, (such as two, too, to; for, four; our, hour; by, buy; write, wright, right), mistakes continually arise during a press of business, and especially where several operators are calling out their messages in the same room. The chances of error with the needle telegraph are threefold—first with the sending; secondly, errors by reading with the eye, which, after watching for some time the rapid movements of a small needle, is liable to confuse the signs; and thirdly, such errors as those referred to between the reading clerk and the amanuensis. A curious error of this class took place before the introduction of the acoustic system in a message addressed to Mr. S. R. Graves, Chairman of the Shipowners' Association, Liverpool—the reading clerk pronouncing the address rapidly, the writer set down the name as S. Hargreaves. With the needle telegraph instrument, a considerable movement of the needle is necessary to render it distinct to the eye, while with the acoustic telegraph the slightest motion of the relay-magnet is sufficient to give a full signal on the bell.

In the recording telegraph, by which messages are registered upon a band of paper in a series of lines and dots, the speed of transmission is much lower from the nature of the signals, the letters being formed by different lengths of one current with intermediate pauses—each pause being equal in time to that occupied by sending a short stroke (or dot), and the long stroke (or dash) being equal to three short strokes or pauses.

The ordinary recording alphabet in use requires for its transmission the time occupied in forming 270 dots; but the needle or acoustic alphabet, by utilising both the positive and negative currents, and requiring no pause when one current follows the other, only requires the time of 153 dots. From the employment of trains of wheels, the recording telegraph does not admit of that facility of conversation and rapidity of correction peculiar to the needle or acoustic telegraph, and hence is not found suitable for railway and many other purposes. It is also open to the same objection as regards error, from the eye of the receiving clerk being continually engaged in deciphering the marks on the ribbon.

The acoustic telegraph is also an alarum in itself, and does not therefore need the addition of a clockwork alarum, such as ordinarily employed in connection with the needle instrument and also the recording telegraph on long circuits.

Both Professor Wheatstone and Dr. Steinheil, of Munich, combined an acoustic system of signalling with their early telegraphs, but the present is the only apparatus of this class which has been found to meet the requirements of practical telegraphy. It consists of a pair of finger keys, capable of the most rapid manipulation, and so connected, that the operator sending does not pass his own currents through his acoustic apparatus, which on the key rising is ready to receive signals on the other end—one key passes the positive and the other the negative current.

The relay is composed of a pair of electro-magnetic coils, with horns on each side acting upon a pair of permanent magnets, one of which makes contact when a negative, and the other when a positive current passes through the relay. The acoustic apparatus consists of two bells of different tone, one on the right and the other on the left hand of the operator; the hammers are attached to the armatures of two electro-magnetic coils.

The relay was patented in 1852, and the acoustic apparatus in 1855, by Messrs. Bright, and their use saves the company several thousands a year in writers.

Re-transmitting Instrument (Messrs. Brights' Patent).

This apparatus was patented in 1852, and is a relay similar in principle of construction to that used with the acoustic telegraph, but so connected that when placed in circuit on one wire at an intermediate point, on receipt of a current (either positive or negative at will) from one side, it will pass forward from a local battery a similar current on the section of line wire on the other side, thus enabling both currents to be transmitted with this relay in either direction, while, with the previous relays, only one current could be turned to account.

Rarefied Air Lightning Projector.

This apparatus was patented by Messrs. Bright in 1852, and consists of a vessel exhausted to such an extent, that any current of a tension likely to prove injurious to the telegraph instruments or insulation, will find a ready passage from the line wire connection through the rarified air to the earth connection, while the less intense current used for working the telegraph will not do so. This can, of course, be exactly regulated by the extent of exhaustion.

The communicating parts of this projector cannot be obstructed by dust, &c.; and, by being hermetically closed, when properly adjusted as to the amount of air, cannot get out of order.

Mode of Regulating Clocks (Mr. R. L. Jones' Patent).

Many methods have been proposed for working clocks by electricity, but all save this plan are open to the serious objection that if the battery gets out of order, or the communicating wire is cut, or the contact defective, the clock is stopped—the electricity being depended upon either as the propelling or releasing agent:—*e. g.* Bain's—*driving* a train of wheels from the pendulum, which owes its motion to an electric current passing through its bob from a galvanic battery which is reversed by each beat of the pendulum acting upon a slight commutator—Shepperd's, which was fixed in the 1851 Exhibition, was governed by a standard clock passing currents to two powerful electro-magnets to propel it. Henley's—with a train of wheels governed from a distance from a standard clock, sending currents to work the escapement of the controlled clock.

Jones' method, on the other hand, simply consists in checking any irregularity of beat in the clocks controlled, by a current passed from the regulating clock through coils forming their pendulum bobs. Permanent magnets being fixed on one or both sides of the centres of their arcs of vibration, the position of each pendulum is exactly determined in relation to the fixed magnets, at the moment the current passes.

By this means any number of large public clocks can be kept in exact unison with an observatory regulator, with an exceedingly feeble current, as the compensation a pendulum requires each beat can be very small indeed. It acts solely as a corrector of errors; and should the wire be broken or the battery be disconnected, the public clocks are not stopped, but merely go on keeping their own time till the current is again passed. The plan has been tried in Liverpool, London, and Edinburgh for some years past with great success, giving no trouble when once applied, and costing very little in the alteration of the pendulum bobs of the public clocks. Some very heavy clocks with old works keeping very erroneous time, have been kept to within the tenth of a second of the regulator for years.

Telegraph Insulators.

Various forms used by the company, and devised by Sir Charles Bright, are shown; amongst others, the double shackle for use when great strain is met with. The principle of this insulator was patented in 1852, and it has been generally adopted for over-house work along the streets of the principal towns of the kingdom. A very compact form of porcelain insulator is also shown, which combines a small spread of surface, vertical sides not affording resting place for dirt, and cheapness of cost compared with others.

Compensation Sending Key.

It has been found necessary in working long circuits to provide for the irregularities of charge produced by different currents. This was pointed out by Professor Thompson in 1858, and others have, as well as himself, made various contrivances for the purpose. The key now shown is one of a simple form, invented by Sir Charles Bright, for circuits of ordinary length, adapted to the use of the common Morse alphabet by the most ordinary operator. Not intended as affording *perfect* compensation for *very* long circuits, but as an every-day instrument, cheap and simple in regulation, and fit to be put in the hands of any telegraph clerk. On pressing down the key, a lever begins to rise, being governed in its rate of motion by gearing into a small train of wheels controlled by a fan, or any other regulator capable of convenient regulation. If a *stroke* is sent, the lever rises as far as a stop, against which it rests until the signal ceases by the key rising. When it touches, the step part of the battery is cut off, or the whole power may be cut off if desired, thus adding to the pause as well as cutting off part of the stroke sent *into* a line, which is equalised at the distant end by the effects of induction.

The Mercurial Relay (Invented by Sir Charles Bright).

Relays have been of two classes—electro-magnetic, in which considerable regulation is requisite, and considerable embarrassment experienced from the irregular polarisation of the iron with varied currents; and galvanometrical, which would be much preferable but for the difficulty of getting contact without strong power; dipping into cups of mercury has been tried, but it requires the needle to be vertical, and the mercury oxydizes on the surface rapidly. This relay has a fine stream of mercury running from one reservoir to another, which the arm of the needle intersects when moved. When one reservoir is exhausted, the apparatus is reversed, and the other begins to run.

The telegraph instruments of Messrs. Highton and Henley are also exhibited by the company, to whom the patents belong. They are simple forms of needle instruments, which have been extensively used for railway and commercial purposes.

The company also exhibit specimens of their two Irish cables, each containing six conducting wires—one laid between Donaghadee and Portpatrick in 1853, and the other between Whitehead and Portpatrick in 1854. The former suffered some injury last year from anchorage, but was repaired and shifted to a better position in the channel, and both are in good working order.

ELECTRIC INDICATOR FOR THE SAFETY OF A RAILWAY TRAIN IN MOTION.

INVENTED BY M. EUGENE VICENZI, LIEUTENANT OF ARTILLERY IN THE ITALIAN ARMY.

The new system of signals to warn a train in motion, in order to prevent the accidents which are so frequent on the railways, consists of the establishment on the line, at every kilometre of distance, of a bar of iron placed horizontally near the rail, and supported by two posts of the same height as the carriages. These bars of iron have a direct communication

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with each other, by means of a wire placed upon the existing telegraphic posts, and which communicates with the station by means of a machinery which is called the "distributor," and with a battery called the "local battery."

On the tender of the locomotive, at a corresponding height with that of the iron bars of which we have made mention, four steel springs are placed, which are intended to touch the bars as the train passes, and which are called "springs of contact." These springs are in communication with the sediment of a second battery called "moveable," which is placed upon the tender of the locomotive, and which sends its opposite pole downwards to the earth, communicating with the wheels and rail. In the circuit of this battery, a bell with an electric spring is placed, which by its sound gives warning to the machinist if any incident happens on the line, and this warning reaches him as soon as the springs of contact touch the bar of iron—and that for the following reason. All the trains which set out from the central station, going towards the extremity of the line, are to have the positive pole of their battery in communication with the springs of contact, and their negative pole below. Thus the stations also will have to put the positive pole of their battery in communication with the wire of the line, and their negative pole below.

On the other hand, the trains which set out from the extremities of the line going towards the central station, must cause the poles of their battery to communicate in an inverse way to the first named,—that is, their negative pole with the springs of contact, and the positive pole on the earth. The stations are to put the negative pole in communication with the wire of the line.

Things being thus disposed, it must happen that the train which goes along the line will meet, at the several distances, the bars of iron which correspond with the wire of the line, and which are in communication with the positive pole of the battery of the station, and, touching them at the moment of its passage, by means of the steel springs, which, as we have said, are in communication with the positive pole of the battery, which is fixed upon the locomotive, there will be obtained the combination of the two positive poles of the two batteries, the effect of which will be, that no electric action will take place, and that the bell will not be rung—but, if, while a train is in motion, the station inverts the pole of its battery, or that the wire of the line is put in communication with the rails, or, that another train coming from the extremity of the line, finds itself on the same rails as the first named, it will happen, that hardly will one of the bars of iron, in communication with the corresponding wire at the station from which the first named train is coming, be touched, than the bell will sound alarum, because at that moment, the combination of the similar poles (that is, the action of the local battery on the wire of the line), will cease, and the batteries of two trains will be able to accomplish their circuit with the earth, by this very wire. By this simple combination, the following results will be obtained.

1st.—An instantaneous communication will be established between the trains in motion and the stations, and *vice versâ*.

2nd.—Means are afforded to give warning to the station from whatever point of the line at which an incident may have taken place.

3rd.—When two trains are moving in the same direction, and one of them is obliged to stop, it can immediately give warning to that one which is following it.

4th.—When two trains are coming towards each other on the same rails, and are in danger of collision, they are mutually warned, and can come to a stop in time.

5th.—In the lines with a double set of rails, it sometimes happens that a train is moving on the wrong rail; in that event it would be warned immediately.

6th.—Each signalman stopping at the place on the line which it is his duty to watch, will be enabled to warn the station, and also the train in motion, in case of any impediment on the line, or any other cause of danger for the train to proceed.

7th.—If a train having been started at a wrong moment, and being actually on the line where it may probably meet with an accident, the station will be enabled to send a signal to stop it or to bring it back, according to circumstances.

8th.—At each station, before the train sets out, all the parts which compose the system will be controlled by speedy and simple means, in order to guarantee the certainty of electric action.

The advantages which we must not forget to mention, are the small expense which the system costs in its construction—thus, many signals can be suppressed, which are now placed along the line, and which require several men to make them work.

It will give occasion to the suppression of a good deal of the present necessary staff of watchers, where there are curves, tunnels, and covered ways; in fine, a certainty and safety in the signals will be obtained, whereas they are now uncertain, from their sole dependence on the actions of the men employed.

Experiments on an extensive scale of this same system were made in the month of October of last year, at Florence, on the railway of Arezzo, and the results have been so satisfactory, that the Directors of the Central Tuscan Railway have requested from the Government authority to apply it on their line, and after consultation with the corps of Civil Engineers, the Directors of the Telegraph, and the Royal Superintendent of the railways, the authority has been given by an official letter from the Ministry of Public Works, dated 16th April, 1862, No. 510, G. B.

Class 13.

HOOPER'S PATENT SUBMARINE TELEGRAPH CABLES, INSULATED WITH INDIA RUBBER, AND PROTECTED BY VULCANITE OR VULCANIZED INDIA RUBBER.

The superiority of india rubber as an insulator is now generally admitted—its applicability for coating submarine telegraph wires is enhanced by its being less affected by heat than any substance standing on the list of insulating media; in the objective, however, we have a much greater degree of porosity, and greater difficulty of ensuring a continuous and permanent homogenity in the coating, and a serious tendency to liquify under the influence of air and heat—assuming first a semi-fluid, and ultimately a perfectly fluid form, which arises from oxidation or the conversion of the india rubber into a soft resin.

By Mr. Hooper's process this alteration in the condition of the india rubber is prevented by an envelope of vulcanite or vulcanized india rubber, which envelope entirely prevents the absorption of water by the india rubber, and at the same time appears to render the insulated core less influenced by heat than in any form of cable yet produced.

The difficulty of applying vulcanized india rubber as a protector for india rubber insulated cores was a matter not easily surmounted, from the fact that vulcanized india rubber could not be united so as to ensure a perfect joint, and from the difficulty of preserving the inner core from the action of sulphur, so as to allow of joints being expeditiously made in the insulating coating. Mr. Hooper found that by the two being kept apart by an intervening layer of metal foil, fibre, or other material, every desideratum for accomplishing these ends was attained.

The consolidation is thus completely effected, the absorption is reduced practically to nothing, and from the circumstance of the consolidation being produced under the vulcanized india rubber, oxidation or any other alteration in the chemical or physical properties of the india rubber, except that of being rendered somewhat more dense, is reduced to an impossibility.

Mr. Hooper is thus enable to ensure the adhesion of the insulating covering to the conductor, perfect joints being expeditiously made, and the prevention of the corrosion of the steel wires, or destruction of the hemp covering for tensile strength.

CAOUTCHOUC INSULATED TELEGRAPH CONDUCTORS.

EXHIBITED BY MESSRS. HALL AND WELLS.

These wires are coated by improved machinery, for which several advantages are claimed—the process being accomplished with such nicety as to enable the manufacturers to insulate separately extremely thin wires, as for instance, a wire ·0079 in diameter, or even finer; they are also enabled to fill up the insterstices of the largest stranded submarine conductors without having recourse to plastic and semi-fluid substances. It is also claimed that the insulating medium is effectually secured by their process against the peculiar form of decomposition which is usually ascribed to oxidation of the caoutchouc.

For subterranean purposes these wires are served with a coating of tarred gum, put in spirally, or braided on by Hall and Well's improved machinery, at the option of the purchaser. This coating of tarred yarn may be almost said to never know decay, hence wires of this description are indispensable for marshes, canals, tunnels, and for every other underground requirement.

They are also fitted for military use, or for any purpose where frequent moving from place to place is necessary, by an additional covering of galvanized wire, sufficiently strong to protect the core from accidental injuries of horses' hoofs, &c.; being thus constructed to lie on the surface of the ground, from whence they can be wound up on drums, and again paid out in any locality fixed upon, at the pleasure of the owner.

Patent Submarine Cables for Deep Seas.

The core of this cable consists of a strand of seven copper wires, insulated with india rubber, further protected by a covering of hemp. The outer covering is constructed with eight longitudinal steel wires, and twenty longitudinal strands of hemp, steeped in pitch and cork dust; these materials being finally braided, upon a new and improved machine made for the purpose, with Russian hemp, saturated with the best Stockholm tar. The specific gravity of this cable is 1·35; weight in air per mile, 0·723 tons; weight in sea water per mile, 0·1874 tons; diameter, 0·75 inch; tensile strength, 2·45 tons; and capable of bearing the weight of 11,635 fathoms when suspended in sea water.

This cable will not kink, and has no perceptible elongation; hence in paying out at sea, no strain can possibly fall upon the core; and its extreme lightness ensures a gradual submersion. For deep seas, therefore, it is far superior to the ponderously heavy iron-clad cables hitherto in use, which, from their great weight, and spiral method of sheathing, necessarily entails the ultimate destruction of the core; since the whole weight of the cable, as it descends with a rush to the bottom, owing to

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the great length necessarily in suspension at a time, causes the spiral covering to elongate, and thus throws the whole strain upon the only longitudinal part, viz., the core, which being thereby stretched to a degree of tension little short of actual breaking, causes the insulating coating to crack, especially if gutta percha, and thus actual faults which render the cable next to useless from its first submersion, or faults in embryo which are certain to appear sooner or later, are entailed by the protective sheathing which was intended to shield the core from all injury.

Nor is it to be overlooked that this cable, although not more than a fourth part of the weight of most iron sheathed cables, is yet not only a far more efficient protective covering for the core, but is equally superior in point of durability; long after rust has eaten into the vitals of galvanized iron, tarred hemp remains strong, perfect, and intact.

Nor is the disparity in point of price less marked than the points above referred to; a triple cable of this description could be manufactured at the cost of one ordinary cable of the old style; and its submersion effected with little or no difficulty, and at a tithe of the expense.

Submarine Cables for Shore Ends and Shallow Water.

These are the first specimens of iron-sheathed cables, with covers of caoutchouc insulation ever made, they contain one, two, three, and four conductors, and average in weight from 3 to 8 tons per nautical mile; these are manufactured expressly for shore ends, and require a strong iron covering in order to protect them from accidents caused by ships' anchors, &c.

The shallow-water cables are constructed upon the same spiral iron-wire clad principle, being liable to be injured by the same accidents as those above-referred to; these cables average in weight from 1½ to 3 tons per nautical mile.

Hall and Wells' Silk-covered Wire for Electrical Instruments.

These wires are of the purest metal, and are covered with a thick coating of the best silk in a superior manner, on improved machinery so exquisitely adapted for the purpose as to enable the operator to cover wires of an unparalleled tenuity; a specimen of this is exhibited by Messrs. Hall and Wells, which measured, before covered with silk, 16,000 yards to the pound.

Copper wires of a diameter ·00871 of an inch are also exhibited, braided into ribbons of 2, 4, 6, 8, 10, 12, 14, and 16 wires in each; each wire being separately insulated with silk in the process of braiding; these are also manufactured for the same purpose as the single wires above noted.

ELECTRIC ANIMALS.

[Continued from page 59.]

The Spaniards apply the name of *Trembladores*—tremblers, indiscriminately, to electric fish; and it is curious that the electric fish of the Nile is termed *Radd*, which signifies the same thing. One species which inhabits the Loire and Garonne, and which is called by the surrounding peasantry *La Tremble*, is eaten, after the electric organ has been carefully removed. The flesh also of the electric eel (*Gymnotus electricus*) is also used as food in America, after the same precaution has been taken; while the *Silurius electricus*, the *Raash*, or thunderer, of the Arabs is much sought by the Egyptians as an esteemed article of food.

The last-named fish, which sometimes bears the name of *Malapterus electricus*, is distinguished from all the true siluri by the absence of the rayed fin on the back, and also by its having no prickles to the pectorals, of which the spines are entirely soft. It abounds in the Nile, the Niger, and the Senegal, usually measuring about twenty inches in length. Its electric organs are far less complex than those of the different species which have been examined, being simply composed of a reticulated mass, filled with an albuminous, gelatinous substance, intersected by nerves, and lying immediately below the skin, over the whole surface of the body. It is destitute of scales; a peculiarity which is ascribed by Humboldt to all the electric fishes, and which is also observable in the whole of the Siluridæ, a circumstance which might lead us to infer that further examination would very probably discover some, greater or less, portion of electric power in their organization.

The Surinam eel, or *Gymnotus electricus*, is found in the greatest abundance in the Orinoco, as well as in its tributaries. It is the largest known electric fish, being occasionally twenty feet in length, although three feet is perhaps the average size. In this fish, the electric organs occupy the whole extent of the under surface of the body, and consist of parallel plates separated by thin layers of mucilage while the skin is constantly covered with a mucous substance, which, as Volta has shown, conducts electricity twenty or thirty times better than pure water. The gymnote is of a fine olive colour; the under part of the head is yellow, mingled with red; two rows of small yellow spots run along the body, and each of these spots contains an excretory aperture, from which oozes the above mentioned conductor.

Several of these fish have been imported into Europe, for the examination of different naturalists, and have become very sociable on the voyage. There is now, or was lately, a remarkably fine specimen in a tank at the Polytechnic Institution, which is as contentedly at home as its brethren in America are untamed and turbulent. Humboldt and Bonpland, finding the small streams, and even the stagnant pools, in some parts of South America abounding with small gymnotes, enjoyed an opportunity of luxuriating in shocks, which a man must be a very keen naturalist thoroughly to appreciate! The first of these philosophers having placed his feet on the body of a fresh animal, experienced a more severe shock than he had ever received from a Leyden phial, and which produced a very satisfactory amount of pain in every joint for the remainder of the day, and of which he appears to speak with decided enjoyment! When he and his companion held a fish between them, they occasionally found that one of them received a shock which the other did not feel, thus making it appear that the eel is able to direct its charge at pleasure to the point in which it is most irritated; sometimes discharging from its whole surface, and sometimes from particular parts only. It seemed most disposed—naturally enough—to bestow its shock when irritated by touching the pectoral fins, the lips, the eyes, the gills, or the organs themselves. The moment of the discharge may be perceived by a slight wrinkling of the skin.

Well known, and often quoted, as is the following graphic account given by Humboldt, it is yet too interesting, despite its savageness, to be omitted when we are treating expressly of electric animals, and we must therefore give it intact:—"The Indians having brought about thirty wild horses, forced them to enter a pool of muddy water surrounded by fir-trees. The extraordinary noise caused by the horses' hoofs, makes the fish issue from the mud, and excites them to combat. These yellowish and livid eels swim on the surface of the water, and crowd under the bellies of the horses. A contest between animals of so different an organisation furnishes a very striking spectacle. The Indians, provided with harpoons and long slender reeds, surround the pool closely; and some climb upon the trees, the branches of which extend horizontally over the water. By their wild cries, and the length of their reeds, they prevent the horses from running away, and reaching the banks of the pool. The eels, stunned by the noise, defend themselves by the discharge of their electric batteries. During a long time, they seem to prove victorious. Several horses sink beneath the invisible strokes which they receive from all sides, in organs the most essential to life, and stunned by the force and frequency of the shocks, disappear under the water. Others, panting, with main erect and haggard eyes expressing anguish, raise themselves and endeavour to fly from the storm by which they are overtaken. They are driven back by the Indians into the middle of the water; but a small number succeeded in eluding the active vigilance of the fishermen. Those regain the shore, stumbling at every step, and stretch themselves on the sand, exhausted with fatigue, and their limbs benumbed by the electric shocks of the gymnoti. * * * In less than five minutes two horses were drowned. The eel pressing itself against the belly of the horses, makes a discharge along the whole extent of its electric organ. The horses probably are not killed, but only stunned. They are drowned from the impossibility of rising amid the prolonged struggle between the other horses and the eels." When the weary gymnoti begin to disperse, and the poor terror stricken horses appear less frightened, the fish are taken by means of small harpoons fastened to long cords. When these cords are very dry, the Indians feel no shock in raising the eels."

The mode of defence with which the eel is endowed has been taken advantage of by the Indians, who, when they wish to ford a river in which it abounds, drive in mules or horses to receive the first and repeated discharges of electricity; well knowing that the fish requires long rest and abundant nourishment after such a struggle, so that for some hours men may pass unmolested. Yet this very means of preparing themselves a passage through the rivers, has caused the entire abandonment of a once general route in the neighbourhood of Uritucu, on account of the numerous mules which were annually sacrificed in crossing the fords. The gymnotus, however, is by no means a destructive animal, but merely employs its instinct of self-defence, and the stunning power with which it is endowed, for the purpose of enabling it to escape the fangs of the alligator, and any other danger, or for the securing of its prey.

A curious fish, called the *Tetadron electricus*, was first discovered by Lieut. Paterson, in the cavities of the coral rocks in Johanna, one of the Canary isles; and it has also been since met with in the American seas. It is a very powerful electrifier, as its first captor found by ex-

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experience; for, having taken one in his hand, he received so severe a shock as to oblige him precipitately to drop his prize. This fish has a long projecting snout, and is about seven inches in length by two and a half in breadth; the back is brown, the sides yellow, the under parts of a sea-green, and the fins and tail of a dingy green hue, while the whole body is spotted with red, green, and bright white marks; the eyes are very large, and the iris of a brilliant red, tinged with yellow, on its outer edges; so that the fish, as may be imagined, is a remarkably pretty one.

The *Trichiurus electricus*, or *indicus*, which is found in the Indian seas, is another of those fishes which has an electrical power; as is the case with several others which have not yet been sufficiently studied or described to be here enumerated. Mr. Maxwell mentions his catching an electric fish, resembling a cod, which weighed thirty pounds. The sailors present declared that "the fish must be haunted," yet the natives [of Congo] gladly received and devoured it. In short, there can be little doubt that great numbers of the inhabitants of the deep possess similar powers wherewith to stupify their prey: and that the study of them will every year bring to light some fresh species.

On the dry land, there is an individual amongst the family of centipedes, which shine out in the mild autumn evenings, and which is frequently passed by under the impression that it is a glow-worm. But, upon examination, it will be found that the phosphorescence is not emitted, as in the last-named creature, from one particular spot, but proceeds from the whole surface of the body; thus perfectly revealing the shape of the animal. "This seems," says Rhymer Jones, "to depend upon some luminous secretion that exudes from the surface of the body; a supposition rendered more probable from the circumstance, that the luminous matter will adhere to the fingers of any person who may seize hold of it, while shining; causing them to shine, as if rubbed with phosphorus, for some seconds afterwards." This scolopendra, which bears the name of *Goephilus electricus*, is able to give a pretty smart electric shock, often indeed sufficiently strong to make the young zoologist drop the prize he may just have secured. This electric power serves the same purpose as that of the torpedo, namely, the securing of its prey.

On turning to the true insects, we find that several of them have, in a greater or less degree, similar powers. Among those so endowed, we may mention the wheel-bug [*Reduvius serratus*]. Major-general Davis tells us that, having taken one of them in his hand, he experienced a shock as if from an electric jar, which he felt as high as his shoulder; on dropping it he found six specks on his hand where the six feet of the animal had stood. There is also an electric bottle, one of the common *Elateridæ*, mentioned by Yarrel, which greatly startled him when he touched it suddenly; while Captain Blakeney was so much affected by the shock received from a large hairy caterpillar of a kind common in South America, that he lost the use of his arm for some time, and his life was even endangered.

When so many eminent naturalists have declared the means whereby the jelly fishes "sting" or benumb the flesh, to be past all power of discovery, it may seem presumptuous in us to suggest whether the so-called sting be not in reality a shock of electricity. The observations of Humboldt would, we submit, appear to favour this solution. He says: "Sometimes on galvanising the medusæ, the phosphorescence appear at the moment when the chain closes, although the exciters are not in direct contact with the body of the subject. The fingers, after touching it, remain luminous for two or three minutes. Wood, on being rubbed with a medusa, becomes luminous, and after the phosphorescence has ceased, it may be rekindled by passing the *dry* hand over it; but when the light is a second time extinguished, it cannot be reproduced." The poet Gray, in a note appended to his sea-side "Amusements," seems to have had a similar idea when he remarked that the medusæ, "if handled, have the effect of a nettle, and the stinging is often accompanied or succeeded by a more unpleasant feeling, perhaps in a slight degree resembling that caused by the torpedo." Be this as it may—be the cause known or unknown—we cannot but gaze, in wonder and admiration, on the power with which an animal of such apparently low organisation is gifted; an animal which, if taken out of its native element, and left to dry, melts as it were, and evaporates, leaving no trace except a glossy surface—a sort of impalpable and glistening film—on the spot where it was laid; furnishing, by its very disappearance, an exquisite proof of the care bestowed by our Creator on the formation and adaptation of form to habit in all his creatures.

GLYPHOGRAPHY.

THE most successful application of the electrotype to engraving is that mode of producing printing surfaces which has been termed by the patentee *Glyphography*. The following accurate account of the process is given in the last edition of Smee's admirable Elements of Electro-metallurgy:—

"This branch of art was invented by Mr. E. Palmer; it forms an important feature for the general illustration of printed works, and on that account demands particular consideration. The term glyphography has been given by Palmer, to signify that the original drawing itself is at once engraved, requiring no copying, and in fact scarcely any instruments, except those with which the artist makes his design. The mode in which so extraordinary an end is accomplished appears ridiculously simple when it is detailed. The most essential part of the process is to make all the surfaces for printing as flat as possible, and for this purpose a plate of copper as used for engraving is first procured. This is blackened with the sulphide of potassium, in order that the draughtsman may be enabled to judge of the effect which his drawing would produce, as he proceeds with his work. This blackened plate is warmed, and then filmed with a compound of Burgundy pitch, white wax, rosin, spermaceti, and sulphate of lead, previously fused together. This composition, which is nearly white, must be uniformly spread over the plate, and the thickness should be about one-thirtieth of an inch. The plate is now ready for the artist, who cuts through the white composition completely down to the blackened copper, and in fact, with the exception of that precaution, makes his drawing in the usual manner. In the selection of tools, the artist should be guided by the manner in which they can completely and clearly cut out the composition; for it is important to make a clear indentation, and not to turn aside the coating and leave a burr. A simple hook, fixed in a wooden handle, a hook filed away on one side, which most effectually cuts away the composition, or a piece of wood tapering to a fine point, are the forms particularly recommended by Palmer. The former instrument is best adapted for very fine lines, the second for larger, and the last for foliage and other free drawings and designs.

When the artist has finished his drawing, the parts of the composition which are removed leave black lines, which have precisely the same relation to the white ground as the black lines in the subsequent print have to the white paper; so that a most important feature in Palmer's operation, is the exact similarity between the design and the print.

Many improvements have of late been made in the process; such, for instance, as giving a greater depth to the lights; for the ground through which the drawing is made being necessarily very thin, printers found great difficulty in keeping their work clean. To alleviate this, the plate is now submitted to the following process. A roller being made of glue and treacle, such as is used by printers for inking their work, is charged with a composition of gum—thus, turpentine, litharge, and red lead—and then passed lightly over the drawing, taking care that the roller is lightly charged in the first instance, that it may not stop up the work. When this coat has become dry, which it will in a very short time if put on thin, the operation must be repeated again and again, until a considerable depth has been given to the work.

When this has been obtained for general work, to the extent required, broad lights should be built up by means of brushes with the same composition, containing more litharge and sulphate of lead, or any other composition which will tend to aid the drying, and is not acted upon by the copper solution in the subsequent process. This part is very essential, or in printing, the paper is pressed to the bottom of what is intended to be a light, and the effect destroyed.

The operator must now allow the whole to get hard, and then with a magnifying glass go carefully over it, and remove anything which may have accidentally got into the lines. He must also then carefully brush it over with the best plumbago, taking great care to rub all out of the lines, or the block, after it is formed, prints rotten by the lines not being sound and firm.

The drawing is now ready to to receive a deposit of copper, and the power of the battery must be carefully regulated to prevent too rapid a decomposition, or the copper is apt to grow over some parts if the line is not well cleared out, and disappoint the artist by work not being copied, which he imagined he had put in.

Having obtained a sufficient thickness in the electrotype trough, and this must vary according to the size of the drawing, the deposited plate is separated, and the back trimmed to receive a layer of type metal, and then, having made the face perfectly flat, the back is turned off, and mounted upon a block of wood similar to a stereotype. Many touches, to relieve different parts, may then be readily put in by a person accustomed to use the graver; indeed, much time is saved by removing the composition altogether in some parts, and putting in any little touches afterwards to give relief to the darks.

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The deepening of the work by the rolling process was a great improvement, by giving to the artist a plate with a much thinner ground than was at first used; but it was subsequently found by Mr. Hawkins, who now carries on the process, that he could likewise form a block upon a common etching ground, which had been so much desired by those accustomed to etching; indeed, practice has now enabled him to form a surface block from almost any engraved plates.

Many very beautiful subjects have been done by this process. Some of the most successful are those well-known prints of "The Bottle" by Cruikshank; but the subjects best adapted are maps, or writing of every description, and here it stands unrivalled both for price and quality.

There is another branch of art to be noticed, which is an invention called the electro-tint, and which may be dismissed in a very few words. A plain copper-plate is procured, upon which the artist makes a painting with some substance insoluble in the solution of sulphate of copper. The plate is placed in the solution and a reverse made, which is at once ready for the printer.

A great many specimens of the electro-tint have been published at different times, and of various degrees of excellence. Sometimes the electro-tint cast is used to print from the hollows, at others from the elevations; thus, in one case, it forms a kind of engraving, at another, a surface similar to that of a woodcut.—*Smee.*

The Student.

NOTES ON ELECTRO-METALLURGY.

Instructions on the theory and practice of electro-plating have been given in Vol. I., pp. 113, 141, and 151. The following observations will be of interest to those who have already mastered the first principles of this useful and interesting application of electricity.

Moulds.—The preparation of moulds to reproduce one side only of an object, such as a coin or medal, presents but little difficulty. If taken in a non-conducting material, the surface should be brushed over with black-lead, as already explained, care being taken that the coating extends to the wire by which the mould is connected with the negative pole of the battery. Bees-wax, or wax and stearine melted over a slow fire with white lead, about one ounce to the pound, until the materials are thoroughly incorporated, is a very convenient material. If the mould of a coin or medal is to be taken, this should be encircled with a strip of cardboard or paper, and a small portion of the melted material poured upon it. It may even be used to take a complete mould of objects of sufficient size, which are not *undercut*, such as vases without handles; such articles, after being moistened with oil, being placed, mouth downwards, in a cylindrical vessel of rather larger capacity than would suffice to contain them, which vessel is then filled with the melted composition. The mould, when cold, may be removed by immersing the vessel for a few seconds in boiling water. The wax mould is then separated into two halves by means of a fine penknife, and the interior surfaces are carefully coated with black-lead. The two halves, when re-united by means of thread, the junction being made waterproof by passing a hot iron over it, may serve as a vessel to contain the metallic solution from which the electro-deposit is to be made; or, the black-lead coating being omitted, the exact form of the vase may be reproduced in plaster.

The plaster of paris used for taking moulds should be of the finest description, mixed with sufficient water to give it, when stirred, the consistence of cream. A small portion should first be brushed into the interstices of the object to be reproduced, so as to prevent the occurrence of air-bubbles. It is usual to saturate the surface of the plaster, when quite set, with boiled linseed oil, which gives to it the appearance of polished marble.

Gutta percha is often used for taking moulds of one side only of a coin, or other object. The material should be gradually kneaded into a homogeneous mass by warming it before the fire, and it may then be placed in boiling water. When removed from the water, the object may be pressed into it; and, when cold, the superfluous gutta percha may be removed with the scissors. Mr. Gore recommends, in preference to gutta percha, a mixture of two parts of this material, with one part of Jeffrey's marine glue. The latter, in small pieces, is melted at a gentle heat in an iron ladle; and the gutta percha, also, in small fragments, is then added and well incorporated. The compound material takes the black-lead more readily than the pure gutta percha.

Moulds of castings of objects for electrotype depositions are frequently taken in fusible metal. The following alloys, which melt at a temperature below that of boiling water, are given in Napier's "Electro-Metallurgy," as suitable for the purpose:—

Tin.	Lead.	Bismuth.	Zinc.
1	1	2	0
1	2	3	0
1	0	1	1

In taking moulds by the *cliché* process, the coin or medal to be copied is moistened with a little sweet oil to prevent adhesion. A small portion of the fused alloy may be poured into a cylinder of card-board sufficiently wide to allow of the introduction of the medal, and the latter is passed upon the metal when this is near the point of solidification; or, the medal may be surrounded with the pasteboard cylinder, so that one end of the latter may project a little beyond the most prominent part of the surface from which the mould is to be taken, and a portion of the fused alloy being placed in a paste-board tray, the medal is brought down upon it with the gradual application of some amount of pressure.

Moulds and casts of objects, such as statuettes, which are complex, and much undercut, are best obtained by the use of an elastic material, such as the following, the application of which to this purpose, has been patented by Mr. Parkes, of Birmingham. A quantity of glue is steeped for some hours in as much water as will moisten it thoroughly, and melted in a gallipot or water bath. When the glue has become fluid, one-quarter part by weight of treacle is added, and brought into intimate admixture with the glue. The process of taking the mould is similar to that already described. The statuette to be reproduced is well moistened with oil, and placed upright in a metallic vessel, such as a tin canister, which, also, has been rubbed with sweet oil. The object, when necessary, should be weighted, to prevent it from floating, and the melted composition is then poured in so as to cover the model. In an hour or two, when the composition has thoroughly cooled, the mould may be removed from the vessel and carefully cut open, so as to abstract the original model. The interior is now a perfect mould of the object, a *fac-simile* of which may be reproduced either in plaster or in a mixture of wax and rosin, with a little stearine or suet, which is to be poured into the mould at as low a temperature as possible.

Non-metallic objects to be coated by the electrotype are generally covered with black-lead; but in some cases Mr. Parkes' patent process is far more convenient for imparting a conducting surface to the model. The fluids used in this process are prepared as follows:—

1. Eight grains of finely cut caoutchouc are dissolved in one hundred and sixty grains of bi-sulphide of carbon. To this solution are first added sixty-four grains of melted wax or tallow which are well shaken up with the fluid. Sixty-four grains of phosphorus are dissolved in nine hundred and sixty grains of bi-sulphide of carbon, and this solution added to the former one. This forms the reducing solution, into which the articles are dipped, for about one minute, previously to immersion in one or both of the following solutions.

2. The silvering liquid is made by dissolving eighteen and a quarter grains of pure silver in about twenty grains of nitric acid, and diluting with twenty ounces of distilled water.

3. The gilding solution is made by dissolving five and a half grains of pure gold in about twenty-two grains of *aqua regia*, and diluting with twenty ounces of water.

The object to which a conducting surface is to be given, is first immersed in the reducing fluid, and after being drained, is allowed to dry for about one half hour. When dry it is immersed in the silvering solution for about one or two minutes, when the surface becomes covered with a black deposit of reduced silver. It may then be immersed in the gilding solution by which the surface deposit is improved. Such delicate objects as leaves and flowers may thus be prepared for the electrotype process.

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Para difficult of sale, owing to the trade shewing no disposition to pay the last speculative high rates.

Fine Java ... ... 1s. 5d. per lb.

Gutta Percha.

There is scarcely anything to be obtained, and, added to the demand for our own use, there are orders in the market to purchase for America.

June 19, 1862. Wm. Kirkmann,

4, Howford Buildings, Fenchurch Street, E.C.

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TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	25 to 30	——
20	Do. B 7 per cent. till 1862 .	all	18 to 20	——
20	Do. C. " "	all	9 to 11	——
10	London & S. of Ireland Direct.	2	— —	——
Stock	Electric Telegraph . .	100	100 to 103	——
5	London District Telegraph .	4¾	3¾ to 3¼ dis.	——
10	Mediterranean Extension Tel.	all	3½ to 4½	——
20	Red Sea and India Telegraph	all	18½ to 19½	19½
1	Submarine Telegraph, scrip.	all	⅜ to ½	——
1	Do. registered . . .	all	⅜ to ½	——
10	Do. " . . .	all	4 to 6	——
2	Telegraph to India . .	1	¼ dis. — par.	——
5	United Kingdom Telegraph .	3	2 to 1 dis.	——

Law Intelligence.

THE BRITISH ELECTRIC TELEGRAPH COMPANY V. DANIELS.

This was a rule calling upon the defendant to show cause why a writ of injunction should not issue restraining the defendant from cutting down the posts, or otherwise interfering with the plaintiff's line of telegraph now in course of construction between Tewkesbury and Gloucester, which line passed along a road running through the defendant's estate, and in front of his house. The defendant objected to the line so passing in front of his house, and wrote to the Magnetic Company, believing it belonged to them. That company forwarded the letter to the plaintiff. A correspondence took place between them, in which the defendant asked to have the wires carried underground in front of his house, and they declined, offering, however, to carry the wires on the opposite side of the road. The defendant objected to the plaintiffs' erecting the poles, &c., on the ground that it came under the clause of "taking land," for which his consent had not been obtained, he being, legally, the owner of the roadway. A second point was, that the plaintiffs were not the parties who were carrying out the works, but that they had improperly lent their parliamentary powers to the Magnetic Company, who have no such power for the construction of this line of telegraph.

Mr. Phipson, Q.C., and Mr. Laxton showed cause against the rule; Mr. Mellish, Q.C., and Mr. Quain were in support of the rule.

Ultimately it was arranged, on the suggestion of the Lord Chief-Justice, that the first point should be settled in a special case, leaving it to the parties to afterwards try the question of fact, if they thought necessary.

Rule absolute accordingly.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of The Electrician.

Dear Sir,—In your number of The Electrician, of March 28th, I notice an enquiry from Mr. T. W. Lowry, respecting the state of several of the Mediterranean submarine cables. Your note is correct, except on one point. "Oporto," I doubt not, should read, "Otranto;" the cable, from the latter place to Vallonea, or Valona, or Avlona, was laid by the Neapolitan Government to meet the Turkish lines, but the Turks were more than a year behind with their wires, consequently, when their land wires were ready the cable (which worked one year) had become defunct, it ceased to exist on the 24th December, 1860. No tests were made, and no attempts at repair, although, I believe, the damage was done by an Australian barque, close in shore, near Avlona. It was laid by Messrs. Newall, and is the same size cable as that of the Red Sea.

Malta, T. L.

To the Editor of The Electrician.

Sir,—From Mr. Siemens's paper, read at the Institution of Civil Engineers (May 20), it appears that a new property has been discovered in india rubber, *viz.*, its dissolution in sea water. I have no doubt that many of your readers are anxious to hear more of this property.

The liability to "faults" from defective manufacture has certainly been overrated by Mr. Siemens: whether the process of "lapping" is attended with greater chances of defects than that adopted by Mr. Siemens, by which he depends entirely on the probability, that the two recently-cut edges will come in contact, must be left to one's own judgment.

Mr. Siemens states very positively, that heating india rubber is dangerous, and "often entailed a gradual decomposition." Now, sir, does Mr. Siemens pretend to tell us that he does not heat his india rubber? If so, let anyone inspect his wire-covering machine in the Western Annexe of the Exhibition. I was assured, only a few days ago, by an attendant, that the india rubber was *heated*, and more than this—"was made quite sticky." It then passed through a solution of soda, "because you could not handle it."

Now, to estimate "the gradual decomposition," we refer to the solution of soda; it tells its own story: the india rubber being oxidized by the process, is placed in contact with an alkaline solution; this dissolves the resinous matter formed by the joint action of heat and air, and becomes more or less tinted, according to the amount extracted from the india rubber.

Mr. Siemens is perfectly aware that india rubber cannot be heated in contact with air. Why, then, Mr. Editor, should he attempt to gall us merely because he can wrap up his deductions in mathematical formulæ—a pity, the dissolution of india rubber, and the impossibility of decay, *à la* Siemens, cannot be reduced to the rigid sway of mathematical demonstration?—Yours respectfully, Honestas.

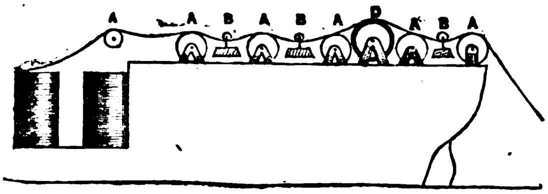
June 9th, 1862.

LAYING SUBMARINE CABLES.

To the Editor of The Electrician.

Sir,—In your kind remarks on the paper read by me before the United Service Institution, you express a confidence which I am not so fortunate as to share, that "the shortcomings which have rendered the old system so disastrous are now very generally understood, and may, therefore, be avoided in future." How can any seaman feel any confidence when such extraordinary apparata and brakes are used, as that described by Mr. Forde (see p. 59), in his paper on the laying of the Mediterranean. First, iron tanks to coil the cable into, utterly ignoring the fact that the cable ought to be in as large a coil as possible; next a short bend out of its prison. Then sheaves "V sheaves," without end, and weights *ad libitum*, on Jack pulleys, I subjoin a drawing of what the thing is (as described). I assume the correctness of the description.

The figure represents portions of the deck of a ship, with the iron tank for the cable, and the paying-out apparatus.



A A. V sheaves. BB. Weights on jack pulleys. D. Drum with 4 or 5 turns round it.

Was there ever such a preposterous arrangement? Do not the contrivers of it know that all bending of a cable is to be avoided? Do they forget that weights on a moveable platform, such as the deck of a ship, increase in weight by the upward pitch, and *vice versa?* Do they suppose that when the ship rolls, as ships in the Atlantic will roll, these weights will remain steady? If I have misunderstood the description, or if it is not a description, I beg pardon of the contrivers, whoever they may be, but in no case can I conceive the possibility of using such a thing for the Atlantic cable, or indeed any other form of brake which has yet been devised, to be placed on a ship's deck. The moveable platform is the one thing which engineers and constructors of ships, not being seamen, seem alike disposed to forget or ignore. Else, why have weights ever been used? Why do we plate armour ships only seven feet below the water line? I must also draw attention to the fact that water ceases to be ballast unless it is confined in comparatively small vessels, and this because some engineers have coolly proposed to let in water as the cable goes out, which amounts either in the hold or in tanks, of such size as to be fit to contain cable, to nothing less than water-logging the ship.

I should not be doing my duty as a naval officer and a quondam surveyor if I did not also loudly affirm that the re-survey of the Atlantic route is neither more nor less than an expensive absurdity, held up to blind and dazzle the public; for if the most talented navigator were told to do his very best, he would never affirm that he could in the middle of the Atlantic, either fix the place of his previous soundings, or his present route of laying, within a mile or so either way of its former course. The bottom is known with amply sufficient accuracy for any practical purpose. The much talked of precipice on the shore of Ireland is 1 in 16, a little less steep than Holborn Hill, and the ooze of the bottom must long since have filled up to a dead level the wonderful cavities over which some heated (or cooled), imaginations have supposed the unfortunate cable to be suspended. Only let the hard heads of engineers treat the cable with as much respect as the soft bottom of the sea will certainly do, and success need not be doubtful—ought not to be deferred.

J. H. Selwyn.

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INDUCTION COILS.

To the Editor of THE ELECTRICIAN.

SIR,—In the construction of induction coils I have always considered that the secondary wire could not be too well insulated, but on reading several remarks of yours it appears to me that this is not the case, and that the better the insulator the less the inductive effect, whether this applies to induction coils or only to submarine wires, I am at a loss to understand; but I certainly think, that if by so well insulating the secondary wire, I do away with the inductive effect, I must be destroying the very properties for which the coil is constructed: amongst these conflicting statements I hardly know which plan to adopt to construct an efficient coil. Again, I have always considered it necessary that the secondary wire should be as close to the primary wire as possible, but a recent extract from a patent, mentioned in your journal, seems to contradict this, as it is there stated, that each layer of gutta percha should be increased as the number of layers of secondary wire are increased. Now, if the number of layers is considerable, I should think that the last layers would be too far off from the primary to cause any increase of power, unless that, after a certain distance is passed from the primary wire, the convolutions of the secondary wire continue, the inductive effect from the maximum distance at which the primary wire loses its effect of induction; if such is the case the length of the primary wire might be increased indefinitely, but the insulation being so much increased (according to what I have stated) would be doing away with the inductive effect. If the effects of the coil depend for its efficiency on the inductive effect of each layer of secondary wire, it certainly appears a curious anomaly that the wire should be recommended to be so well insulated, at the same time (according to the various statements) the inductive effect is being done away by the superior insulation. In one of your extracts from the Government Report it states, the "conductivity of the wire does not influence the amount of inductive effect." It would appear from this that iron wire might be used with the same effect for the secondary wire as copper, and, as far as I have experimented on this point, I see no reason to doubt it. I have commenced a coil, the secondary wire of which is of iron, No. 36 guage, uncovered, wound on side by side with cotton of the same size, and merely separated with sheets of writing paper, so that, although well insulated, I am not doing away with the inductive effect, as the interposition of cotton, or paper, increases the inductive effect; and I must say that, as far as I have proceeded, it is quite equal to the effect I should have obtained from copper wire. I shall be glad if you can enlighten me on any of these points.—Yours respectfully, J. COOK.

TELEGRAPHIC JURORS FOR THE INTERNATIONAL EXHIBITION.

To the Editor of THE ELECTRICIAN.

SIR,—In reading the article on the above subject, published in your last number, it cannot but be considered by everyone a very great mistake in the Commissioners appointing persons for the office of jurors who are directly or indirectly interested in any of the inventions exhibited in Class XIII.; as there are many considerations that weigh heavily against getting a fair and unbiassed opinion from persons who feel bound to advocate their own principles, either in manufacturing instruments or cables, and in doing so they may be neglecting many important inventions that ought to receive due appreciation. The whole of the exhibitors, I consider, would be fully justified in representing their case, with a view to the appointment of men who are known to possess mechanical, as well as scientific knowledge, and capable of deciding on the best instruments, the best cable and materials to be used, and also the best methods of applying that material. These are points necessary for giving effect to the decisions of the jurors appointed, and may avoid us becoming the laughing stock of France and other nations, who, I am fearful, will ultimately be great gainers by the want of that encouragement so necessary for the advancement of this science. In England, true it is, we have laid many lines—very many unsuccessfully. Unfortunately for us as a nation, monopoly has much interfered with progress; mismanagement, and a deficiency in scientific knowledge as also tended much to stay the carrying out of many submarine lines; and the appointment of jurors is, at the present moment, highly important with a view to create new confidence.

And in conclusion, I would urge every exhibitor to unite and obtain the appointment of Mr. Fairbairn, and one or two others of his class, which would avoid the certain unpleasantness of decisions unworthy of us as a nation, and not fairly representing the science of this subject in all its various parts.—I am, sir, yours obediently, CITIZEN.

To the Editor of THE ELECTRICIAN.

SIR,—Your late article, headed "Telegraphic Jurors for the International Exhibition," has given form and expression to a feeling which has been almost universal amongst telegraphic exhibitors. It is well known that no person connected with electrical pursuits can address a paper to the Royal Society without having such paper submitted for the approval of the telegraphic patentees who have the good fortune to belong to the council of this body. It would be rather hard if there were no means of placing electrical inventions and improvements before the public, without having the merit of the same decided upon by gentlemen whose peculiar position as patentees appears to unfit them for the post of unbiased and disinterested arbitrators upon matters involving the possible adoption of systems and inventions in actual competition with their own.

A PATENTEE.

To the Editor of THE ELECTRICIAN.

SIR,—When two bodies charged with opposite kinds of electricity are brought near to each other, light objects, such as feathers or pith balls, will oscillate between them. Can you please inform me the reason that a thunder cloud passing over the earth within striking distance has not a similar effect on light substances?—Yours respectfully, X.

THE following letter has been addressed to the Editor of the *Times*:—

SIR,—I believe that when an erroneous statement gets into your paper, calculated to do injury to an individual or to a locality, you seldom refuse to insert a contradiction. On this plea I must beg leave for a few words.

My attention has just been called to an article in the *Times* of the 9th inst., under the head of "Naval and Military Intelligence," relating to the Atlantic Telegraph, in which the following passage occurs:—

"It is stated that in the event of a second attempt to establish telegraphic communication across the Atlantic, some place on the coast of Ireland further north than Valencia will be selected for the purpose of obtaining a more convenient bed for the reception of the wire."

Now, I should like very much to know on what authority that statment is made. Being myself the proprietor of the greater part of the Island of Valencia, and having from the first taken the deepest interest in the Atlantic telegraph, I might naturally be supposed to know if such a change was intended. I believe this statement to be absolutely without foundation, and I know to a positive certainty that no cause exists to make such a change necessary or desirable. The best proof that the "bed" of the ocean at and near Valencia is neither inconvenient for the laying of the wire, nor unsuitable to its permanency, is, that the Atlantic cable (as your readers are aware) was laid there, in spite of many adverse circumstances, in August, 1858. It has lain there ever since, through several winters, severe beyond the average, and I have within the last two or three months taken up a considerable portion of its shore end, on the most exposed part of our coast. The portion thus taken up has been found in such perfect state of preservation that without any delay I have used it to connect the Island of Valencia with the mainland, and it now forms a portion of a continuous line of telegraph between Valencia and Greenwich Observatory, by which the Astronomer Royal is at this moment carrying on some interesting experiments as to the longitude.

Perhaps the writer of the article in question will be kind enough to point out the place on the coast of Ireland, whether north or south of Valencia, which has been thus effectually tested, and which has been found more "convenient" than Valencia for the "reception" and maintenance of a cable.—I have the honour to be, sir, your most obedient servant, P. FITZGERALD, Knight of Kerry.

Union Club, June 16th.

Miscellanea.

A CURIOUS accident lately happened at the International Exhibition, by which, had it not been for the promptness with which it was discovered, the building might by this time have been reduced to ashes in a very scientific manner. Among the most noteworthy objects in the Japanese court were two spheres of rock crystal, about five inches in diameter, ground and polished with mathematical accuracy. They were exhibited by Messrs. Baring Brothers, and attracted very little attention from the general visitors. One very sunny day, however, a person rushed into the superintendent's office with the alarming intelligence that "the two glass globes had caught fire." On hastening to the spot it was found that the spheres had acted the part of burning-glasses, and had concentrated the rays of the sun, which was shining full upon them, on to the mahogany stand, which was then in a blaze. These globes have now been removed to the Chinese court, where the curious visitor may see two holes in the stand large enough to insert the top of the finger. These holes are of some interest, as they are each double, showing in a very perfect manner the double refracting properties of the quartz.

To Correspondents.

F. C.—The manufacture of electro-plated goods is principally carried on in Birmingham. The metal bismuth may be readily deposited from a solution formed by dissolving either the nitrate or the subnitrate in a mixture of nitric acid in water. Bismuth forms a very beautiful deposit, having a fine silky lustre, and a somewhat pinkish tint.

ERRATUM.

Page 54, 9th line, "Bonelli's Telegraph Apparatus," for "67 feet" in length, read "6 or 7 feet" in length.

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The Electrician.

VOL. II. No. 34.—JUNE 27, 1862.

CONTENTS:

	PAGE		PAGE
Steps to Theory by the Practice of Electricity	85	Lightning Conductors	92
Signalling Instruments	87	Physical Science	93
Some Considerations on the Principles of Electrical Conduction and Accumulation	87	Proceedings of Societies	93
International Exhibition	89	Prices Current of Insulating Materials	94
Description of the Automatic Printing Telegraph	90	Telegraph Shares	94
		Recent Patents	94
		Correspondence	95
		Miscellanea	96
		To Correspondents	96

STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 74.]

303. PRESUMING that we have satisfactorily made out the *nature* and *causation* of electrical retardation, always experienced more or less in the transmission of our telegraphic signals, we shall find it easy to comprehend electrical *resistances;* that is to say, what we represent as obstructions to the transmission of electricity through conducting matter. We have seen that retardation is a real hindrance, an entity, caused by inertia, that requires time to be occupied in the action of the electrical attraction by which it is overcome; this we can understand is what the public has been prepared to believe, as it has also to regard resistances as a term indicating, on the contrary, nothing more than a passive inability of the thing which is said to be resisting to do an amount of electrical conduction that its nature has not qualified it for. Thus, if a conducting wire be capable under given circumstances of passing along it only a certain quantity of electricity, then, being unable, of course, to pass *under the same circumstances* two such quantities, we permissibly speak of its inability to pass the second quantity, as its resistance to electrical conduction; making resistance to be a nonentity—a mere *imaginary hindrance*, varying necessarily in a simple inverse proportion with conductivity. Now this simple view of resistance is not quite the one we take; we are compelled to regard the term as having a compound sense, including the idea of retardation by inertia, as we have explained it, because in every instance of electrical conduction the velocity of the electricity must be diminished by inertia. We have, therefore, now to consider electrical resistance with respect to the two-fold meaning of the term.

304. We know the practical law of resistances to be that it makes the conductivity of a wire of uniform nature and substance to vary inversely as its length, and directly as the area of its section. That law we have also deduced from our doctrines as a consequence of inertia; and it must be true of resistance considered in its other aspect also, because resistance means simply retardation by inertia when only length of conductor is concerned and the area of section constant; while, on the other hand, whenever resistance means more than retardation by inertia, as in the case of variable sectional areas, the passive hindrance is resolved into mere absence of conductivity.

305. The view we thus get of the two elementary parts of electrical resistance, individually and relatively, is an intelligible one, quite adequate to save us from some mistakes in practice to which we were liable before they could be well defined. Let us, in illustration, suppose that we have established two conducting lines of insulated copper wire of uniform quality, each communicating at one end with the ground, the wires being equal in length, and one of them ten times the diameter of the other. In such a case it is obvious that with a given intensity we should be able to pass through the larger of the two wires a hundred times as much electricity in a given time as would pass by the smaller wire, the velocity of current in the two being then equal; and it is equally clear that if the length of the larger wire were to be made a hundred times that of the smaller wire, the velocity of the current along the former would be reduced to the one hundreth part of what it was before. Such an increase in length would, of course, cause equal quantities of electricity to be passing through the two wires; because, first, an unit of quantity travelling with a speed of the one hundreth part of unity gives the same product as the one hundreth part of a unit of quantity passing with the one hundreth part of an unit of velocity; and because, secondly, the retardation by inertia would be equal in the two wires, the quantities of common matter, as well as of the passing electricity in them, respectively, being equal. If we understand the longer and larger of our two imagined wires to represent a telegraph conductor, and the shorter and thinner wire to be a coil devised to offer an equivalent amount of retardation by inertia, their comparison will teach us that our theory justifies the practice commonly instituted for estimating resistances by means of what are known as resistance coils, but it forbids our coming to the same conclusion respecting the means adopted for reading the comparative indications of those coils and of telegraphic wires, as we will now explain.

306. It is universally understood that the deflection of the needle of a galvanometer keeps pace with the quantity of electricity passing in a current around it quite irrespective of every other circumstance; whence it arises that we may increase the deflection, first, by increasing the dimensions (all other conditions remaining the same), of our electro-motive elements, provided the wire of the coil be maintained adequately large to conduct all the electricity furnished; secondly, by increasing the number of electro-motive cells worked in series, by which also increased quantity of electricity is furnished and delivered over to the coil in a given time to pass through it in the form of a more energetic current, in which case also the wire of the coil must offer an appreciable amount of resistance; and, thirdly, by elongating the coil, each turn that it makes within certain limits adding to the quantity of electricity circulating around the needle at any given instant of time. Now, as the telegraph wire and the resistance coil above imagined pass in a given time equal quantities of electricity, we shall have the conditions for establishing in two galvanometers, one connected with each of them, equal deflections, provided only, we take care that the velocities, unequal in the two cases, be in neither case checked, which it may easily be if we employ galvanometers that are alike. For example, let the end of the resistance coil be made into a galvanometer coil; it would then, of course, be competent to transmit the small but rapid current as quickly as it arrived: in like manner if the extremity of the larger conductor were made the galvanometer coil, it also would be adequate to pass onward the larger current, as it presented itself more slowly. But if, instead of all this the smaller galvanometer were put to discharge the larger conductor, the greater volume or breadth of current it could receive from it would be only proportionate to its own section, while the rapidity of the reception would be as the slowness of the arrival. We perceive, therefore, if these deductions have been rightly made, that we have perhaps something more to attend to than has hitherto been known, before our experimental results with resistance coils will be in all cases perfectly worthy of being depended upon.

307. While upon the subject of electrical resistances, we may refer to a circumstance of some interest, at least in a theoretical point of view; every one knows that copper is a much better electrical conductor than iron, that is to say, that in a given time a wire of the former metal can convey along it a much larger quantity of electricity than a similar wire of iron. Now this, as is evident, may result either from a broader current or from a more rapid one through the copper, but our theory informs us that velocity for equal lengths of wire of all kinds must be constant, being only retarded by the inertia of the passing electricity; that inertia being always proportionate to the quantity,

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so that every particle of electricity is equally retarded; and, so far as we have yet traced it, it does not deny to the current through the copper a greater breadth. Practically, this greater breadth would be made out, and our theory so much further confirmed, if it could be proved by experiment that the velocities through copper and iron were equal; now we have had given us by MM. Fizeau et Gounelle for the velocity along copper wire 111,834 miles in a second of time, and by MM. Guillemin et Burnouf for the velocity along iron wire 111,847 miles per second: which it must be admitted is a remarkable approximation. It is true the former experimentalists obtained with iron wire only 62,130 miles per second, but we may legitimately infer, as suggested by the Government Reporters, that the numbers given by "the more recent experiments" on the iron wire are the more correct.

308. We think we have said enough to make apparent that resistances, apart from retardation by inertia, would bear pretty much the same relation to electrical conductivity that darkness does to the presence of colour, or coldness to the presence of heat —all being negations of entities that might be.

309. Our view of resistances is, however, not the only one lately submitted for judgment to the readers of the The Electrician; an attempt being now in actual progress to establish electrical resistance as an active entity irrespective of electrical motions, and therefore of retardation as we understand it, with relation both to conduction, and also to what is represented as its alternative, electrical accumulation. With our particular views this effort could only be made successfully by showing that an absolute absence of causation—a passive incapacity in matter, is energetically in exercise, originating effects and making them keep pace with itself as their immediate cause. When new conceptions, having some element of truth, are admitted into our physical systems, before the proper place for them has been clearly made out, it rarely happens that they are not sooner or later magnified into an importance they have no pretensions to; and this we consider to be eminently the case at the present moment with respect to the doctrine of resistance. We are compelled to notice it, as it cannot be passed over without leaving our subject incomplete; but we shall notice it with the less reluctance because to prove its unsubstantial character it will require at our hands only to be contrasted with a very few experimental facts.

310. The doctrine we refer to follows in the wake of the "Researches," so far as to regard all the kinds of matter as being more or less perfectly electrical conductors; the whole of them being able to perform the function of conduction to some extent, while in certain of them the conductivity is so great and in others so inconsiderable, as to warrant their practical division into the two classes of conductors and insulators. We need not stop here to state the arguments that our theory supplies with respect to that alleged universal attribute of common matter; we shall for the moment concede it to be true in order to have an undisputed starting place for our reasoning, it being sufficient for our purpose that the atmosphere is admitted to be, for all practical purposes, an insulator.

311. The principles involved, so far as we find it necessary to describe them, are these: electricity disturbed from its normal condition of distribution, will be either conducted back again to it, or, if that be prevented, accumulated on or against conducting surfaces as near as possible to the place of its natural distribution; all bodies conduct it more or less freely, and all hinder its passage more or less forcibly, this power of hindrance in bodies being called their resistance. The electricity that is not conducted accumulates on the conducting surfaces to which it has access; and for that accumulation to be possible there must be around those surfaces other conductors for the electricity when accumulated to act upon by induction. The charged conducting surfaces must be separated from the inductive surfaces by media whose conducting powers are, practically speaking, infinitely bad, or what is the same thing, whose resistances are infinitely good, or the electricity would be conducted and not accumulated.

312. Now what we have to do with is this: atmospheric air is one of the substances termed insulating, because it is infinitely bad for favouring conduction; it is also, by this doctrine, infinitely good to resist the accumulation of charge, and therefore its presence around an insulated conductor should not confer upon that condutor what we know as a charging capacity.

313. We may remark in passing that these allegations do not in the slightest degree pretend to throw light upon the nature of resistance, or its cause; that is all left open to be filled up by future discoverers, whereas those who have made themselves conversant with our doctrines will hardly be able to refrain from wishing to perceive some mechanical principle on which resistance could by possibility be enabled to act in the way represented. If, as we have said, active resistance be the retardation caused by inertia—if there be no inertia where there is no conduction—and if there be no conduction of electricity from the surface of a conductor when it has a charge acting inductively on the surrounding air, or through it on things beyond; then there can be no active resistance anywhere to be opposed to anything, whether it be conduction or accumulation.

314. The proposed doctrine of resistances to which we are objecting, may be supposed to have its confirmation in the mathematical demonstrations by which it is accompanied, but such a supposition should be guarded against; many of the problems would equally apply if for the word *resistances* we were to substitute *assistances*, which of course would introduce a notable change,— and one which we think ought to be introduced,—into the causation; while others of them represent electrical effects that have no counterpart in fact.

315. But we will give a few other experiments in justification of our proposal for reversing the alleged electrical causation, and for regarding the air as assisting instead of resisting electrical accumulation; we can easily prove in a practical manner that this is actually the office performed by the atmosphere, and to experiment afresh to establish that truth would have been a work of supererogation had we given the past portions of our essay less rapidly than we have done, and thus have afforded more time for their full investigation; for they contain throughout their entirety a network of evidences which, if deliberately examined, would, we think, render indubitable our explanation of resistances. We refer again to our former pages, with the utmost confidence that the research will not disappoint anyone who will take the trouble to go into it minutely.

Exp. 34. Procure a brass ball an inch in diameter, with a projecting stem an inch in length, and cement the latter firmly into one end of a glass tube several inches long, varnished inside and out. Pass the other end of the tube through the top of a capacious glass receiver, securing it there by means of a stuffing box in such a way that the ball shall occupy the centre of the receiver, and be distant from its sides and crown five or six inches. Coat the inside of the receiver with tin-foil, stand it in conducting communication upon the plate of a good air-pump, and exhaust it more or less perfectly.

316. In this state of things, if, as the doctrine we are examining teaches, air resist the accumulation of charge, we shall have more favourable conditions for accumulation than before the air was drawn from the receiver; but if the doctrine be untrue, and the air promote accumulation, then the conditions for accumulation will be less favourable.

317. Now, to see which of the two really be true, place in the glass tube, which should be long enough to reach two or three inches above the receiver, a straight piece of wire, and by its means bring the inclosed ball into conducting communication with a small charged conductor connected with a gold leaf electrometer. Thereupon the divergence of the gold leaves will be but little diminished, which will be the first indication that but a small quantity of electricity will have passed to the ball; but in order

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to know accurately the accumulation in the ball, draw out the wire of communication by a dry thread of unspun silk, let the air slowly return into the receiver, and then, having removed the latter from the plate, place the insulated ball in momentary contact with the electrometer; the divergence that will result from that contact will then be found very small, and smaller as the air had been more rarified.

Exp. 35. Replace the receiver, and repeat the experiment without first removing any of the air from around the ball; in this case a considerable diminution will take place in the divergence of the gold leaves by the electricity leaving to enter the ball; and the charge of the ball, when examined as before, will cause in the electrometer a far more considerable separation of the leaves.

318. In these experiments the tin-foil coating really had no practical effect, but there being metal around the ball would have answered the purpose of fulfilling more perfectly the conditions upon which, had the alleged resistance any foundation in nature, the results obtained ought to have been exactly reversed.

319. It is hardly worth while to devise, or even to perform, experiments as an antidote to error that we feel has already been abundantly administered to; and therefore after the present one, and saying that another was long ago given by us (par. 149, *exp.* 24), that alone ought to have proved sufficient for its purpose, we will conclude by merely referring to some others very pertinent to the present case that were performed by Sir W. Snow Harris, and are to be found in the "Philosophical Transactions" for 1834, page 229. Of those experiments it will suffice here to say that Harris found the quantities of electricity accumulated on the surfaces of conductors surrounded by air to increase exactly in simple *direct* proportion with its density; and from that fact, apart from all others with which these pages abound, a conclusion must be drawn that is fatal to the doctrine of atmospheric resistances to electrical accumulation.

320. With this exposition of the causation and nature of electrical resistances, we shall for the present terminate what we have had to say on the subject of electro-telegraphy, merely remarking in addition that our task has chiefly been to make known, as clearly as we could within the compass of the few pages that might be devoted to that purpose, the theoretical principles that are involved, rather than an elaborate application of them to all the cases that would have readily suggested themselves. We have passed over many things that we desired to enter largely into; and, amongst others, have omitted to show the manner in which, according to our doctrines, even *induction* from a charged telegraphic wire could be practically made a most useful auxiliary.

SIGNALLING INSTRUMENTS.

THE vast amount of ingenuity and study which has been expended in the construction of instruments for telegraphic signalling can be very fairly realized by ordinary observers in a more or less extended series of visits to the International Exhibition. It is not so easy, however, to discriminate the relative practical value of the various inventions, and perhaps the general impression is that the greater number of the instruments are of almost equal value under different circumstances. To a certain extent this is doubtless the case; for a system which might be the most efficacious and profitable for a telegraph company, whose business is always susceptible of increase by a reduction of tariff, might be less applicable where the transmission of messages is limited, and where the means of signalling and of receiving signals are required to be accessible to all. But in the general point of view of telegraphic progress, it is almost impossible that the advantages of any two systems should be precisely equal. It is sometimes with a feeling of regret that after arriving at the comprehension of the beauty of any particular instrument, we are forced to admit either that its period of usefulness has gone by, or that it is surpassed in practical value by other inventions. But the tests to determine rapidity and correctness of signalling are simple and inexorable, and, when extending over a sufficient period of time, should be sufficient to enable any intelligent and disinterested observer to arrive at a definite conclusion relative to the best form of signalling instruments adapted to general telegraphic purposes.

It will be generally admitted that for such purposes the various forms of needle instrument are now *hors de combat.* For rapidity and consequent cheapness of signalling, we hold that the dial instruments, with step-by-step motion—albeit they engross the greatest amount of interest on the part of the general public—are also inapplicable. However rapid their manipulation may appear, the results seldom are found to surpass five or six words per minute. There remain the recording instruments, and those which print the message in roman type. Among the latter are found the beautiful instruments of Professor HUGHES and Signor BONELLI, which have done much, but yet have more to do, to establish their claims to the first rank in practical utility. The recording instruments, properly speaking, are those which hitherto have given the most valuable results in regard to speed and accuracy. The modifications of the Morse recording instrument, which are at the present moment in general use in England and abroad, have been brought to a condition of perfection which, in most directions, is considered almost to preclude the possibility of improvement. The application of an automatic system of working to recording instruments appears, however, on very ample evidence, to be an important desideratum. We give this week a description of the automatic recording instrument of Professor WHEATSTONE, and in fairness we have also to direct particular attention to that of Mr. THOMAS ALLAN, now exhibiting at Kensington, and which will amply repay a lengthened examination on the part of those who are interested in the great problem of cheap telegraphy. We propose next week to enter into the consideration of the advantages offered by the system of automatic transmission, of which these instruments are the chief representatives.

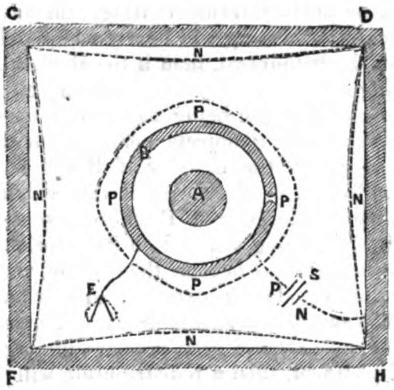
SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 77].

LET A (fig. 71), be a spherical conductor, surrounded by, but insulated from, a conducting shell B, which is also insulated from the surrounding surface C D F H, and let E be an electroscope

Fig. 71.



attached to B. Then if the positive pole of a source, having its negative pole connected to the surrounding surface, be connected to B, the exterior surface of B and of the electroscope will become positively charged, an equal quantity of negative becoming disposed on the surrounding surface, and the electroscope will therefore diverge. The interior surface of B, and the surface of A, will be unaffected, as they are not surfaces in

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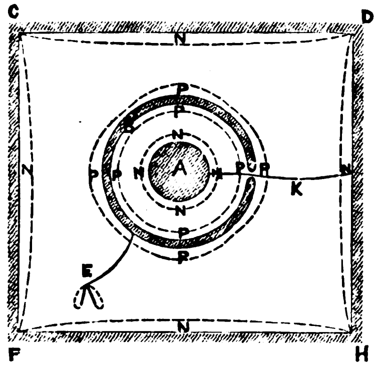
the inductive circuit, which may be traced thus: from the P pole of the source to the exterior surface of B, then across the air in every direction to the surrounding surface C D H F, which is in conductive connection with the N pole of the source. Let the source be withdrawn, and the distribution as shown will remain unaltered. If now the conductor A is connected to the surrounding objects, by a wire K passing through an aperture in B, as shown in figure 72; then since the surface of A, and the

Fig. 72.



interior surface of B, are opposing surfaces, and are each in connection with one of the two charged surfaces, a redistribution must take place in accordance with the resistances now separating the exterior and interior surfaces of B from the surrounding surface K L M N, and from the surface of A. Some of the positive on the exterior of B, and on the electroscope E, will therefore pass to the interior at the same instant that some of the negative from the surrounding surface passes to the sphere A. The electroscope E will therefore decrease its divergence, and the distribution is represented in the figure by the dotted lines. The quantity on the interior of B will now be to that on its exterior, as the resistance separating B from the surrounding objects is to that separating B from A.

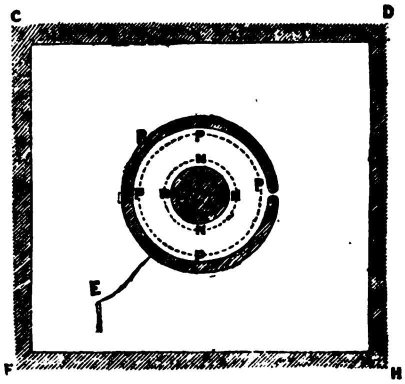
If, therefore, the interior conductor A nearly fills the shell B, and the surrounding objects are distant from the exterior of B, nearly the whole of this charge on B will be transposed from its exterior to its interior surface. In the same way, if an insulated Leyden jar be charged on its exterior, then on connecting the interior coating to the surrounding objects nearly all the charge will be transposed from the exterior to the interior of the outer coating. An equal quantity of the opposing and equal charge of opposite electricity on the surrounding objects passing from the surrounding objects to the internal coating, and an electroscope attached to the exterior coating will nearly completely collapse.

Let the wire K be withdrawn, then if the shell B be connected to the surrounding objects, the positive quantity on the exterior of B, and on the electroscope, being equal and opposite to the negative on the surrounding objects, complete neutralization of the electrical charge on the exterior of B will ensue, and the electroscope E will cease to diverge; but this will not affect the electrical state on the interior of B, as represented in fig. 73. Thus the shell B, from being charged on its exterior surface, and uncharged on its interior has become the reverse, viz., charged on its interior, and uncharged on its exterior. A portion of the whole charge having, however, been neutralized in the operation.

If now B be again insulated from the surrounding objects, and A be connected to them, then a redistribution will again occur, some of the negative passing from A to the surrounding objects, and some of the positive passing from the interior of B to its exterior, and the distribution will again become the same as that shown in fig. 72; the total quantity being now less, the density at all parts will be less than that which existed before B was touched to the surrounding objects.

If now the wire K be again withdrawn, and the exterior of B again placed in connection with the source, connected as before, the exterior of B will become charged up to the same density as before, and if the source be withdrawn, and A touched to the

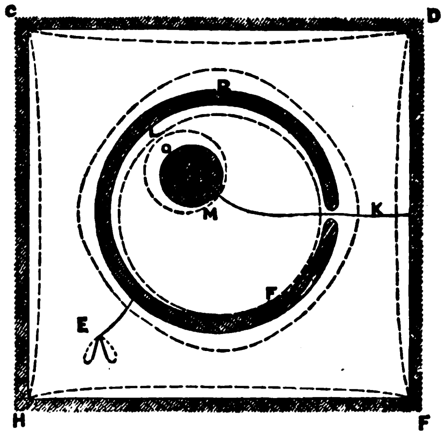
Fig. 73.



surrounding objects, a redistribution will again take place, and some of the charge on the exterior of B will pass to the interior. If these operations are continually repeated the charge on the exterior of B, and on the interior, will approach very nearly (though it never can quite), to the same charge that would be produced by maintaining A in connection with the surrounding objects, by means of the wire K, at the same time that one pole of the source is applied to B, whilst the other is connected to A and the surrounding surface, as represented in figure 43.

If when the distribution is that shown in fig. 72, A be moved to some other position within B (as shown in fig. 74), then it can easily

Fig. 74.



be demonstrated that the inductive resistance is decreased between the more proximate parts O L of A and B, in a greater ratio than the resistance is increased between the more widely separated portions M and F, and consequently the total resistance separating A from the interior of B is decreased; A being still in connection with the surrounding objects, a redistribution on all the surfaces will therefore ensue, some of the negative from the surrounding surface, C D F H, will pass to A, an equal quantity of positive passing from the exterior to the interior of B, and the total quantity now on A, and on the interior of B, redistributing itself on those surfaces according to the resistances now separating them in different directions. The total quantity on the exterior of B is therefore less than before, and this will distribute itself according to the resistances separating it from the opposing surrounding surface, C D H F; and as these resistances are unaltered, and the proportionate distribution is consequently the same as before the quantity was decreased, the quantity on the electroscope will be less, which will be indicated by its decreased divergence.

As long, therefore, as the sphere A remains in connection with

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the surrounding objects, its position within B will affect the total quantity on the exterior of B, which will be indicated by the electroscope.

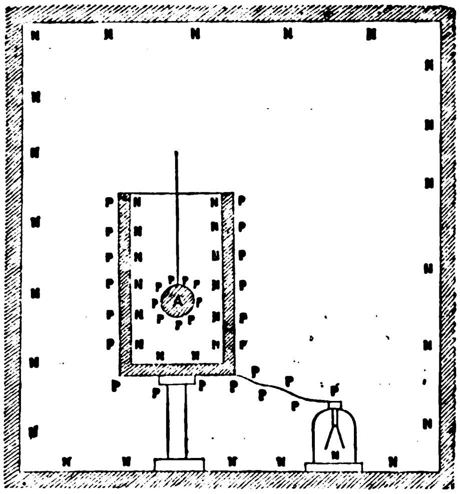
If now the connecting wire K be withdrawn, then since A is not in connection with any other surface from which it could receive any electricity, or to which it could allow any of its own charge to pass, the total quantity on it cannot be altered by any change of position within B (provided it is not placed so near to B as to allow its opposite charge on B to recombine with and neutralize it). The opposite positive charge on the interior of B is on disconnecting A equal to this negative charge of A, and consequently since the charge of A is always the same, no more could be added to the positive charge on the interior of B, or subtracted from it without making it unequal to the negative of A. None of the charge on the exterior of B will therefore tend to pass to the interior, nor will any tend to pass from the interior to the exterior. Whatever is the position therefore of A, it cannot affect the total quantity on the exterior of B, and since this quantity distributes itself according to the resistances separating the different parts of the exterior surface of B from the surrounding surface, the electrical state of the exterior of B cannot be affected in any way by the movement of the sphere A, although the distribution of the charges on the interior of B, and on the sphere A may become greatly altered by a change in the position of the latter.

If B be an insulated and uncharged shell, and A, being inside B, be charged positively, from a source having its negative pole connected to the surrounding objects, then, as we have before seen, the shell B will become polarized in its thickness, the charge on its interior will be exactly equal and opposite to that on the sphere A, and the charge on the exterior of B will be equal and opposite both to that on its interior, and to that on the surrounding surface.

If now the source be withdrawn, then in the same way any alteration in the position of A will cause the distribution on A, and on the interior of B to become altered, but will not affect the electrical state on the exterior of B in any way.

If the ball A is charged positively when exterior to B, then an equal quantity of negative will exist on the surrounding surface, and if the ball A be then introduced into the shell B, B will, in the same way, become polarized; and if the charge of A is the same as that which it received when within the shell, the whole electrical state will be the same as in the previous experiment, and no alteration in the position of A will affect the electrical state on the outside.

Fig. 80.



The truth of this is exemplified, and indeed was first pointed out by Professor Faraday's experiment with an insulated ice-pail to which I have already alluded.

In whatever position the sphere A was placed within the ice pail, provided not too near the open top, the same divergence of the electroscope attached to the outside of the pail occurred.

If, therefore, any two surfaces in an electrical state to one another are separated entirely by a conductor insulated from both surfaces, then this intermediate conductor will become polarized, so that each of its surfaces will be in an exactly equal and opposite state to the excited surface to which it is opposed; but although the polar state of the intermediate conductor is the result of the action of both the surfaces which it separates, the distribution on either of its surfaces will be entirely independent of the distribution on the other; this distribution on either side being solely dependent on the different inductive resistances separating that surface from its opposing surface. Thus in the fig. 74 if the wire K is removed and the ball A moved to any other position, the points of maximum density at O and L would move to the nearest point separating A from B, but not the slightest alteration in the distribution of the charge exterior to B would result, and consequently no alteration in the divergence of the electroscope E.

(To be continued.)

International Exhibition.

SPECIMENS EXHIBITED BY MESSRS. SILVER AND CO.

ONE of the most interesting objects to the telegraphist is the celebrated "standard" or "C" wire, so often referred to in the Government Report, and exhibited by Messrs. Silver in Class XIII. It consists of a No. 16 copper conductor, coated spirally with caoutchouc to $\frac{7}{16}$ of an inch in diameter; the insulating material being perfectly consolidated by the application of a moist heat. This sample, upon which the Government tests and experiments were made, has been under water for a period of more than two years; and, after the many vicissitudes to which it has been exposed, remains a most favourable example of the applicability of caoutchouc for the insulation of submarine wires. Besides other specimens of insulated conductors for aërial, subterrannean, and submarine purposes, Messrs. Silver exhibit the following:—

Cables for aërial purposes, containing 10, 15, 20, 30, 50, and 60 conducting wires, each wire separately coated and insulated with caoutchouc.

Special cables, patent, for deep sea purposes.—The conducting wire insulated and protected conjointly with prepared india rubber and ebonite.

Iron coated cables for submarine purposes.—The conducting wires coated and insulated with patent caoutchouc.

Insulators, various, for line wire, aërial, and other similar purposes, constructed in ebonite, ebonite and metal, ebonite and wood, ebonite and porcelain.

Electrical (frictional) machines.—The plate and supports constructed in ebonite.

Electrophorous discs, of ebonite.

Voltaic battery cells, ebonite.

Improved voltaic batteries, gravity and graphite.

Photographic baths and trays, ebonite.

These various specimens fully illustrate the progress of the special branches of manufacture which they represent.

C. S. DUNCAN'S RATAN DEEP-SEA ELECTRIC TELEGRAPH CABLE.

AMONG the telegraphic novelties, the ratan covered cable of Mr. Duncan claims some amount of attention. The cane has long been used by the Chinese and the Malays for cables used in anchoring and making fast their junks, and it is asserted that its silicated covering suffices to preserve it from the attacks of marine animalculæ, while the absence of albuminous and saccharine matter renders its chemical decomposition extremely slow. As a covering, uniting extreme lightness with considerable strength and toughness, the ratan appears on *primâ facie* consideration to be peculiarly suitable for deep-sea wires, and it is desirable that all the conditions attending its use should receive investigation. For the shore ends of cables it would seem to be inapplicable, unless in combination with iron, which would better resist the effects of abrasion. The supply of the cane is inexhaustible, and its price is stated to be inconsiderable. The specimens of telegraph cable are accompanied by three cables received from China, which have been subjected to wear and tear in anchorage, &c., for a considerable period.

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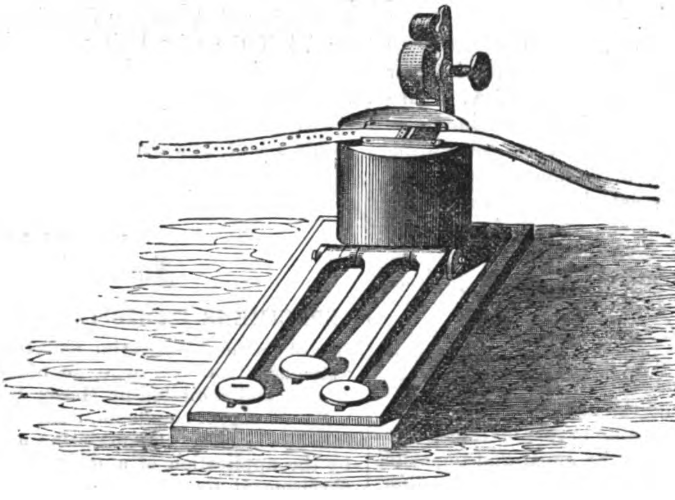
DESCRIPTION OF THE AUTOMATIC PRINTING TELEGRAPH.

BY C. WHEATSTONE, F.R.S., CORRESPONDING MEMBER OF THE ACADEMY OF SCIENCES AT PARIS, ETC.

[From the "Comptes Rendus" of the Academy for January 24, 1859.*]

I HAVE the honour to submit to the Academy a new Automatic Printing Telegraph, which, I believe, possesses advantages which have hitherto been unattained. With the instrument at present on the table 500 letters per minute have been printed. The perforated bands of paper, which determine the order and succession of the electric currents by a means analogous to the mechanism of a Jacquard loom, are prepared in such a manner that the groups of points constituting the different letters are distinctly separated, so as to render any mistake arising from the coalescence of adjacent letters, which now frequently happens, impossible; and effective ink-marks are impressed on paper without adding in the least to the weight, or causing any resistance to the moving parts of the electro-magnets.

This invention consists of a new combination of mechanism, for the purpose of transmitting messages, previously prepared, through a telegraphic circuit, and causing them to be printed at a distant station.

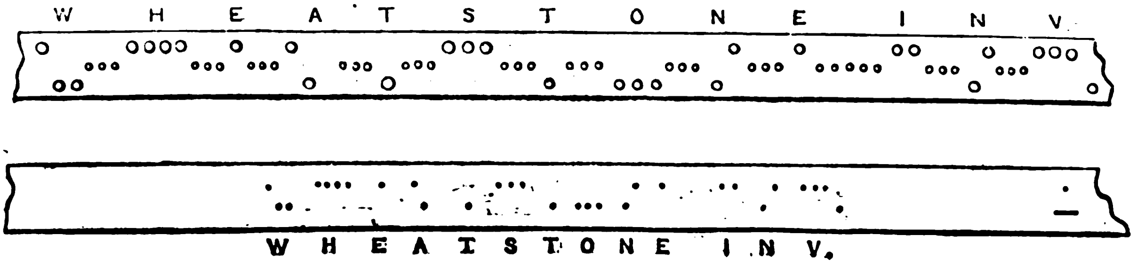


The Perforating Apparatus.

Long strips of paper are perforated by a machine, constructed for the purpose, with apertures grouped to represent the letters of the alphabet and other signs; a strip thus prepared is placed in an instrument associated with a rheomotor (or source of electric power), which on being set in motion, moves it along, and causes it to act on two pins, in such manner that when one of them is elevated the current is transmitted to the telegraphic circuit in one direction, and when the other is elevated it is transmitted in the reverse direction: the elevations and depressions of these pins are governed by the apertures and intervening intervals. These currents, following each other indifferently in these two opposite directions, act upon a writing instrument a distant station, in such manner as to produce corresponding marks on a slip of paper moved by appropriate mechanism.

I will proceed more particularly to describe the several parts of this telegraphic system: observing, however, that each part has its independent originality, and may be associated with other apparatuses already known.

The first apparatus is a *perforator*, an instrument for piercing the slips of paper with the apertures in the order required to form the message. The slip of paper passes through a guiding groove, at the bottom of which an opening is made sufficiently large to admit of the to and fro motion of the upper end of a frame containing three punches, the extremeties of which are in the same transverse line. Each of these punches, the middle one of which is smaller than the two external ones, may be separately elevated by the pressure of a finger-key. By the pressure of either finger-key, simultaneously with the elevation of its corresponding punch, in order to perforate the paper, two different movements are successively produced—first, the raising of a slip which holds the paper firmly in its position, and secondly, the advancing motion of the frame containing the three punches, by which the punch which is raised carries the slip of paper forward the proper distance; during the reaction of the key, consequent on the removal of the pressure, the slip first fastens the paper, and then the frame falls back to its normal position. The two external keys and punches are employed to make the holes, which grouped together represent letters and other characters, and the middle punch to make holes which mark the intervals between the letters. The perforations in the slip of paper appear thus:—

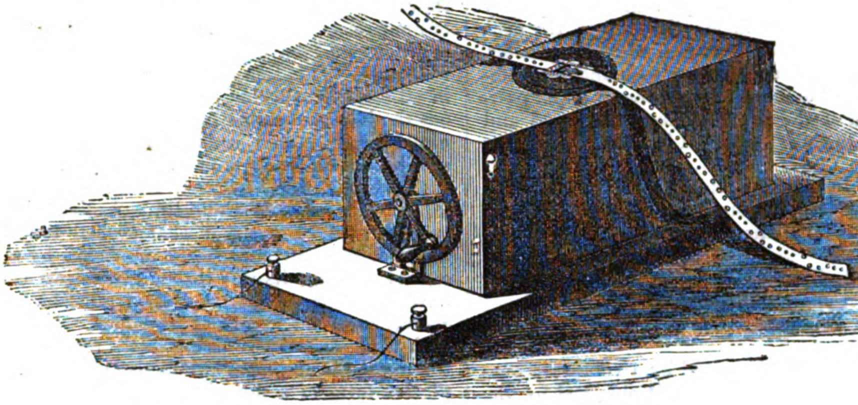


Perforated and Printed Paper.

A very simple addition to the perforator enables a printed message which has been received to be retransmitted to a more distant station, without any translation or knowledge of the meaning of the message. The printed band which has been received is made to pass between two rollers, one of which is moveable by a finger-screw, so as to cause the characters to pass successively before the eyes of the operator. The keys of the perforator are acted upon with the right hand, and the finger-screw with the left, as the characters successively appear the keys are pressed down in the order of the points of which the letters consist, an operation which scarcely requires any skill to perform.

* This Telegraphic System was patented in England, June 2, 1858.

There need be no change in the alphabet which is at present employed; the points at one side may represent the short dashes, and those at the other side the long dashes, their order remaining the same as in the existing system.



The Transmitting Apparatus.

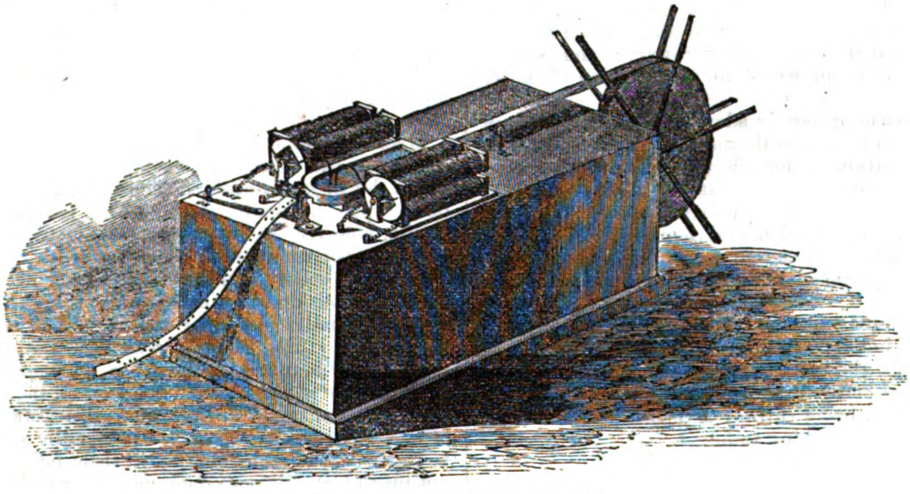
The second apparatus is the *transmitter*, the object of which is to receive the slips of paper prepared by the previously described instrument, or perforator, and to transmit the currents produced by a voltaic battery or other rheomotor, in the order and direction corresponding to the holes perforated in the slip. This it effects by mechanism somewhat similar to that by which the perforator performs its functions.

An eccentric produces and regulates the occurrence of three distinct movements—1st. The to and fro motion of a small frame which contains a groove fitted to receive a slip of paper, and to carry it forward by its advancing motion. 2nd. The elevation and depression of a spring-clip, which holds the slip of paper firmly during the receding motion, but allows it to move freely during the advancing motion. 3rd. The simultaneous elevation of three wires placed parallel to each other, resting at one of their ends, over the axis of the eccentric, and their free ends entering corresponding holes in the grooved frame. These three wires are not fixed to the axis of the eccentric, but each of them rest against it by the upward pressure of a spring, so that when a light pressure is exerted on the free ends of either of them, it is capable of being separately depressed. When the slip of paper is not inserted, and the eccentric is in action, a pin attached to each of the external wires touches, during the advancing and receding motions of the frame, a different spring, and an arrangement is adopted by means of insulation and contacts properly applied, by which, while one of the wires is elevated and the other remains depressed, the current passes from the voltaic battery to the telegraphic circuit in one direction, and passes in the other direction when the wire before elevated is depressed, and *vice versâ;* but while both wires are simultaneously elevated or depressed, the passing of the current is interrupted. When the prepared slip of paper is inserted in the groove and moved forward, whenever the end of one of the wires enters an aperture in its corresponding row, the current passes in one direction, and when the end of the other wire enters an aperture of the other row, it passes in the other direction. By this means the currents are made to succeed each other automatically, in their proper order and direction, to give the requisite variety of signals. The middle wire only acts as a guide during the operation of the current.

The wheel which drives the eccentric may be moved by the hand or by the application of any motive power.* Were the movement of the transmitters effected by machinery, any number might be attended to by one or two assistants.

This transmitter requires only a single telegraphic wire. If desired the despatch may have only a single row of apertures; in this case the perforator must have only two keys, and the transmitter two pens instead of three.

The third apparatus is the recording or printing apparatus, which prints or impresses legible marks on a strip of paper; corresponding in their arrangement with the apertures in the perforated paper.



The Recording or Printing Apparatus.

The pens or styles are elevated and depressed by their connection with the moving parts of the electro-magnets. The pens are entirely independent of each other in their action, and are so arranged that when the current passes through the coils of the electro-magnet in one direction one of the pens is depressed, and when it passes in the contrary direction the other is depressed; when the currents cease, light springs restore the pens to their elevated point. The mode of supplying the pens with ink is as follows:—A reservoir about an eighth of an inch deep, and of any convenient length and breadth, is made in

* Instead of a voltaic battery, a magneto-electric machine, or an electro-magnetic machine, may be employed as the source of electric power. In this case, the transmitter and the magneto-electric or electro-magnetic machine form a single one, apparently moved by the same power. They are so adapted to each other the shocks or currents are produced at the moment the pins of the transmitter enter the apertures of the perforated paper.

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a piece of metal, the interior of which may be gilt, in order to avoid the corrosive action of the ink placed in it; at the bottom of this reservoir are two holes, sufficiently small to prevent by capillary attraction the ink from flowing through them: the ends of the pens are placed immediately above these small apertures, which they enter, when the electro-magnets act upon them, carrying with them a sufficient charge of ink to make a legible mark on a ribbon of paper passing beneath them. The motion of the paper ribbon is produced and regulated by apparatus similar to those employed in other register or printing telegraphs.

The fourth apparatus is an instrument which I call a *translator*. Its object is to translate the telegraphic signs, consisting of successions of points or marks, adopted in this system, into the ordinary alphabetic characters.

In the system I have adopted, limiting the number of points in succession to four, thirty distinct characters are represented.

I will conclude by offering a few remarks on the advantages possessed by this system.

Whatever practical dexterity may be acquired by a voluntary operator, the result arrived at will be far inferior to that obtained by the automatic process, which is only limited by the rapidity with which the recurring motions of the transmitter can be effected. By the present construction of the instrument, five times the quantity of signs at present used can be transmitted to moderate distances; though for very considerable distances this rapidity may be limited in conductors subjected to inductive influences, by the tendency which rapidly recurring short currents have to coalesce.

But even if there were no advantage in point of rapidity possessed by the automatic over the voluntary process of transmission, its other advantages would be incontestible. For the profitable working of a telegraphic line, it is necessary that the operator should manipulate as rapidly as is consistent with a correct transmission of the message; it requires great skill to become a proficient in such manipulations, even when the language in which the despatch is sent is quite familiar to the operator; but if he would send a despatch in a language unknown to him, or in cipher, he is obliged to proceed with caution and slowness. In my new system, the prepared messages are transmitted with equal rapidity in whatever language or cipher they may be; and as the perforated bands may be prepared at leisure, and be subjected even to the revision of a corrector, guarantees of accuracy are obtained which cannot be afforded by the system of immediate voluntary transmission. Several clerks will be required to prepare messages for a single telegraphic line in constant activity; but in an economical point of view their time is of far less importance than the time occupied by the transmission of a message.

Another advantage this new system possesses is, that the same prepared message may be transmitted through any number of distinct lines, if not simultaneously, at least in such rapid succession as to be equivalent thereto; and besides, without any fresh labour, the same message may be retransmitted if thought necessary; and service messages in constant use may be preserved for transmission whenever they may be required.

Were this automatic system generally adopted it might, in many instances, be more convenient to prepare the messages at the offices from which they are sent, the instrument for effecting this purpose being very portable and of small cost. The operations at the telegraph office would, in these cases, be limited to passing the perforated band through the transmitter at one station and receiving the printed message at the other, the translation as well as the preparation of the message devolving on the department of the administration to which it relates.

In the present case it is not the question to substitute one kind of acquired skill for another kind equally difficult to attain, which would entail great labour on all the employees. The great practical dexterity at present required being dispensed with, and the principal and most laborious operation being entirely automatic, there is little to learn though there may be something to forget.

LIGHTNING CONDUCTORS.

The first and most obvious practical result of Franklin's discoveries was the *lightning conductor* for the protection of buildings and ships from the violent effects of the disruptive discharge. The first lightning conductors consisted merely of metallic rods or chains, proceeding from the highest point of the building or the ship, in a direct line to the earth or to the sea: but this was not found in all cases sufficient. Instances have occurred in which the conductors have been fused or shattered—and hence arose a prejudice against their use, under the idea that they did more harm than good, by inviting the destruction they were intended to prevent. An attentive examination, however, of numerous cases of damage from lightning has shown that the path of discharge from the cloud to the earth is always in the line of least resistance. This line may not be the shortest lineal distance, but it is in all cases the shortest electrical distance; that is, the lightning picks out the best conductors in its transit to the earth, selecting with the nicest discrimination metal cramps and fastenings, and by its expansive power shattering and destroying inferior conducting substances, such as wood, brickwork, and stone.

The discoveries of Franklin and other philosophers of the last century very fully prove that what we call thunder and lightning is the result of disruptive discharge produced by a great natural electrical agency, forcing its way through resisting matter, and which, as we have just seen, is attended by irresistible expansive force with an evolution of intense light and heat. Now this agency in finding a path through matter offering little resistance to its progress, such as the metals, is no longer productive of such disruptive effects. The explosive form of action either vanishes altogether or becomes so modified as to merge into a sort of current, traversing the metal with a greater or less degree of rapidity. If, therefore, a building or a ship were perfectly metallic in all its parts, no damage could possibly arise to it when struck by lightning, since the explosive action would vanish from the instant the electrical agency entered the metal. In applying lightning conductors, therefore, as a means of guarding against the destructive effects of lightning, our object should be to carry out this principle in all its generality, and bring the given building or ship as nearly as possible into that state of passive electrical resistance it would have supposing the whole mass were metallic throughout. Now this is best accomplished by connecting together, so far as possible, all the large detached masses of metal in the fabric, and between which disruptive discharge is likely to ensue, and then unite these with capacious conductors leading directly from certain of the highest points of the structure directly to the earth or sea. These conductors should, of course, be metallic, but as metals vary in conducting power, copper, being the best conductor, is to be preferred. It has been found that a copper rod of one inch in diameter, or an equal quantity of copper under any other form, will resist the expansive and heating effects of any discharge of lightning hitherto experienced. In applying such conductors to buildings, they should be fixed to the masonry and project into the air by sharp or pointed terminations; below, they should terminate in two or more branches leading under the surface of the ground, and, if possible, to moist earth, drains, or springs of water. In applying such conductors to ships, each mast should have its own capacious conductor permanently fixed and connected with bands of copper passing through the sides of the ship under the deck-beams, and with the large bolts leading through the keels and keelson, and including, by other connections, all the principal metallic masses employed in the construction of the hull. Under such a system, a discharge of lightning falling on a house or a ship finds its way to the earth or to the sea without the possibility of damage.

Much discussion has arisen relative to the amount of security such conductors can insure, when compared with the quantity of lightning, which, by their supposed attractive influence, might become drawn down upon the buildings to which they are applied: such controversies, however, are now very completely disposed of by the great natural experimental facts which have presented themselves upon this question, especially within the last twenty-five years. The notion that lightning rods draw down lightning upon a building in virtue of a specific attractive power for the agency of lightning is not only unsupported by any evidence whatever, but is positively at variance with the whole course of experience. It is now well known that metals have not, *per se*, any greater influence on the electrical discharge than other kinds of matter. Lightning will always find for itself a path of least resistance to the earth: if metallic substances be present and be convenient to its action, it will then fall on them, but not else; if not present, it will seize upon any other body which is convenient to it: so that metallic conductors can be no more said to attract the lightning which falls on them at the time of a thunder-storm, than a rain-pipe can be said to attract the rain which falls on a building at the moment of a shower; the action of both is purely passive; any calculation of the radius of protection of a lightning rod, therefore, in virtue of its attractive power on the agency of lightning, will necessarily be fallacious, as is, in fact, shown by experience. Several cases have occurred in the Royal Navy in which one mast of a ship has been shivered by ligtning, a chain conductor having been applied to the other. It is by no means uncommon to find heavy discharges of

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lightning strike upon the sea in the vicinity of such conductors, as if avoiding them altogether.

If we, for a moment, look at the course of experience, we can have no longer any doubt upon this question. In this country alone, the amount of damage which has occurred, and still continues to occur, by lightning, especially to churches, is beyond all credence. Fuller says, in his "Church History": "that scarcely a great abbey in England exists which, once at least, was not burned down with lightning from heaven;" and then he enumerates a great many so destroyed. In modern times we may observe similar destructive effects. Now, it is notorious that in no case where such destruction has occurred, has the building been provided with lightning conductors: on the contrary, no instance of damage has arisen to any building to which such conductors have been efficiently applied; the exceptions being so insignificant as not to be worthy of record. If we look at the destructive effects of lightning in ships, the results of experience are most especially interesting and conclusive. It appears from the records of the Navy, that the destructive effects of lightning on Her Majesty's ships involved in former years an expenditure of not less than from £6,000 to £10,000 annually; in 200 cases only, 300 seamen were either killed or hurt, and above 100 large masts, valued at the time at from £1,000 to £1,200 each, entirely ruined. Between the years 1810 and 1815, no less than thirty-five sail of the line and thirty-five frigates, and smaller vessels, were completely disabled. Now, since the system of lightning conductors, just described, has been fully carried out in all Her Majesty's ships, it appears that damage by lightning has positively vanished from the records of the Navy.

The following is an interesting and remarkable instance of the beneficial action of such a system of conduction as that we have adverted to, taken from the official journal of one of Her Majesty's ships. The *Conway*, a small frigate of 28 guns, being moored in the harbour of Port Louis, in the Isle of France, was, at 11 a.m., of the morning of the 9th of March, 1846, struck by lightning. At this time the ship was under refit, the higher or top-gallant masts down on the deck, so that to support the pendant a small spar, *not having a conductor on it*, was substituted for the main top-gallant mast, being fixed at the head of the top-mast. Now the terrific flash which fell on the vessel first struck this spar, and shivered it in atoms: at the point of junction, however, with the large copper conductor on the top-mast below and leading to the sea, all further destruction ceased; the explosive action vanished, and the electrical discharge streamed safely into the water, apparently expanding upon the surface in a blaze of brilliant light. The brief notice in the ship's log runs thus:—"11.45. Pendant staff at main topmast head shivered in pieces by lightning; conductor carried off the fluid without further damage."—*Sir W. Snow Harris.*

PHYSICAL SCIENCE.

On the Action of the Voltaic Pile on Salts of Potash and Soda, and Alloys submitted to Igneous Fusion, by M. GIRARDIN.

M. GIRARDIN has just completed, in the laboratory and at the expense of the Duc de Luynes, a long series of experiments on the electrolisation of salts and alloys submitted to igneous fusion. We have space only for his principal conclusions, and for some simple and easy experiments in support of them.

1. In the electrolytic decomposition of potash and soda salts submitted to igneous fusion, the oxygen alone goes to the positive pole, the two radicals of the acid and of the base going to the negative pole.

By plunging the poles of the battery into a crucible containing fused borax, an abundant disengagement of oxygen takes place at the positive pole, and at the negative pole bubbles of sodium which burn on the surface. After the experiment the negative pole is found surrounded by a considerable deposit of amorphous boron.

2. The presence of excess of alkali does not vitiate the results, and imparts the advantages of conductibility and fluidity, which admit of the operation being performed with batteries of from one to four ordinary elements of Bunsen, and in ordinary furnaces. Platinum poles are much less attacked than in operating at a higher temperature without the addition of alkali.

All the salts of potash and soda can be decomposed in this manner with the greatest ease. M. Girardin has operated upon borates, silicates, zincates, stannates, chromates, manganates, titanates, molybdates, uranates, aluminates, arseniates, arsenites, antimoniates, phosphates, sulphates, carbonates, and nitrates, and in every instance oxygen only was disengaged at the positive pole.

The decomposition of uranates and phosphates furnish the best experiments. With uranates globules of potassium or sodium appear at the negative pole, and detonate in the midst of a shower of uranium sparks. With phosphates, when the current has ceased to pass there is a brilliant combustion of phosphorus at the negative pole at the termination of the experiment.

Chlorates alone are the exception to the rule. Chlorine and oxygen are disengaged simultaneously at the positive pole. But this anomaly may be attributable to the decomposition of chloride of potassium, which takes place when the heat has begun to decompose the chlorate of potash.

3. Bodies which tend together at the negative pole are in a state of mixture rather than in a state of combination. The proof of this lies in the absence of phosphuretted or siliciuretted hydrogen in the decomposition of phosphates or silicates, to which is added potash, which is always hydrated. The combustion of phosphorus after the decomposition of phosphates, is a further incontestable proof of this proposition.

4. The poles are often attacked. Thus, if in decomposing silicates an ingot of aluminium is taken as the negative pole, the aluminium alloys itself to the potassium and sodium set free. In presence of water this alloy yields spontaneously inflammable siliciuretted hydrogen.

5. During the decomposition of chlorides, bromides, iodides, sulphides, &c., the positive pole is energetically attacked, and the compound formed decomposes a short time after, under the influence of the current.

Thus, by placing a positive copper pole in a crucible containing fused sea-salt, it will be observed that, after the passage of the current, half the crucible will take a greenish-blue colour, from the chloride of copper, and the other half red, from the metallic copper.

With iron poles the action is more complex; for the sea-salt attacks the oxide of iron unless hindered by the action of the current. On this point the Duc de Luynes has performed an excellent experiment, hitherto undescribed. He threw some pieces of iron into a crucible containing fused sea-salt, and filled up the crucible with pieces of earthen crucible. Chloride of iron forms, which, under the influence of humid air, is transformed into oxide, the earthen pots at the same time becoming covered with a multitude of crystals of oligist iron, identical with those of the Island of Elba.

6. The electrolytic decomposition of compounds formed at the expense of the poles is not identical in the dry and the wet way. Thus, when copper poles are used, if the same current is passed into fused or dissolved sea-salt, there results in the first place chloride of copper and reduced copper, and in the second place, hydrate of sub-oxide of copper, of a beautiful yellow colour.

7. When several bodies are fused together, their electrolytic decomposition is not simultaneous, but successive. Thus, in the decomposition of uranates, sparks of uranium appear before the bubbles of potassium. This is attributable to the reducing action of bodies with strong on those with weak affinities. This is easily proved by dissolving oxide of copper in fused borax. When the borax is nearly solidified the bubbles of sodium detonate slowly, and the blue colour imparted to them by the dissolved oxide of copper will be superseded by the red of the reduced copper.

8. All alloys, without exception, lose their homogeneousness when traversed by the current. Thus, fused plumbers' solder when electrolyzed becomes brittle at the positive pole, and soft and malleable towards the negative pole.

The amalgams and alloys of potassium and sodium can be operated upon when cold. The amalgam of sodium decomposes water when taken at the negative pole, but not at the positive.

Potassium and sodium alloy, under the influence of the current, solidifies at both poles.

9. Whatever the electro-chemical rank of a metal, if present in small quantities in the alloy, it goes always to the negative pole.

The amalgams of gold and bismuth dissolved in mercury may be taken as examples. Whatever the amalgamated metal, it always returns to the negative pole.—*Comptes Rendus.*

Proceedings of Societies.

LIVING *ACARI* IN SOLUTIONS OF NITRATE OF SILVER.

A PAPER descriptive of *acari* found in or rather upon nitrate of silver baths for photographic purposes has been communicated by Dr. Maddox to the Microscopical Society. The animalculæ in question are somewhat larger than the cheese mite, and are described as somewhat resembling fat sheep. They appear in every case to have been located upon the surface of the

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fluid, the vessel containing which was covered with a sheet of foolscap paper, the substance of which may have furnished the nutriment necessary for the development of the *acari*. Under the microscope, the presence of fat in the animalculæ was rendered evident; treated with iodide of potassium they furnished a precipitate of iodide of silver.

The following observations, which may be of interest to some of our readers, are taken from the report of the meeting of the society.

Mr. Wenham asked whether Mr. Shadbolt had had an opportunity of comparing Dr. Maddox's insects with those which Mr. Crosse found some years ago in an acid preparation?

Mr. Shadbolt said he had not, and believed that it was precisely the object of Dr. Maddox in bringing the subject forward to obtain information from those who had seen the *Acarus Crossi*.

Mr. Wenham said that Mr. Crosse found the *Acarus electricus* or *Crossi*—as the insect was called—in great quantities, having a pearly appearance, in solutions of nitrate of copper, and he thought it was a question whether the insects were actually in contact with the corrosive solution, or were encased in coatings of air.

Dr. Lankester said that Dr. Maddox's paper was a very interesting one, having regard both to the nature of the insect and the place in which it was found, and thought the Society must refer to their entomological friends for the history of the creature. There was a great analogy between the creatures found by Dr. Maddox and Mr. Crosse. The Society was, very properly, referred to the supposition that the animals had been developed from *ova*, under some circumstances. Mr. Crosse had also shown that *Acari* would live under circumstances which to higher animals would be fatal; others were known to feed upon poisons, such as strychnine, and capable of eliminating from it hydrogen, oxygen, and nitrogen, and of converting, even into fatty matter, poisonous and acid solutions. He (Dr. Lankester) recollected being, many years ago, very much astonished at finding a large number of organisms in the sulphuretted hydrogen waters of Harrogate, and among them many forms of *Confervæ*, which he described at the time, and which were then interesting in consequence of the place in which they were found. He was reminded of a paper by Dr. Pereira, in the *Pharmaceutical Journal*, on *Fungi*, found in solutions of mineral substances. Dr. Maddox's paper opened up an inquiry into the forms of animal life which were not destroyed by that which destroyed the higher forms of life.

Mr. Wenham said there was one great distinction between the animals of Dr. Maddox and the *Acarus Crossi*; for those of Dr. Maddox were found on the surface of the solution of nitrate of silver, while the *Crossi* were found deeply immersed in the solution of nitrate of copper.

The Rev. J. B. Reade thought that the word "on" used by Dr. Maddox in his communication, gave a different notion of the nature of the creature and its *habitat* to that of the *Crossi*. The photographs exhibiting it structure, its mandibles, and other portions of its body, proved that it had something different to feed upon than the solution of nitrate of silver. It was questionable whether Dr. Maddox had stated distinctly that they were found in the solution as water spiders were found.

Mr. Shadbolt said that the paper clearly said "on" the surface.

The Rev. J. B. Reade said then that he thought Dr. Lankester had imagined that the creatures were actually existing immersed in the solution, and could float about as water spiders and other creatures did. If the members adhered to the author's word "on" they would not necessarily come to the conclusion that the creatures fed upon the fluid.

Mr. Slack mentioned that in the experiments of Mr. Crosse the creatures did not survive unless they got out of the liquid.

Mr. Wenham said he recollected that Mr. Crosse mentioned that when the creatures were detached from the positive pole of the battery they perished, and that seemed to have confirmed the notion that they must have been enveloped in a *film of air*.

Dr. Lankester did not think that *Acari* could be developed only upon strychnia, any more than other creatures could continue to exist in nitrate of silver; and the question therefore arose what was the nature of the material on which the creatures fed? There must have been other agents than nitrate of silver contributing to the creatures' nutrition.

Mr. Shadbolt, in reply, stated that the conditions under which the creatures were found were very distinctly expressed in the paper:—"When the solution was returned to the bath, half-a sheet of white foolscap paper was first folded down on the top, and then the cover placed over it." The only possible materials upon which they could have fed must have been either the nitrate of silver, or the portion of the paper which was over the surface. Dr. Maddox found that on treating them with iodide of potassium they produced the well-known yellow precipitate of iodide of silver.

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Para.—The market continues extremely flat. The ship "Cupid" has arrived at Liverpool, with about 80 tons, making now the stock there about 540 tons. Prices are nominal.

Last price paid for

Fine Old Dry	1s. 10d. per lb.
Fine Java	1s. 5d. „

Gutta Percha.

A very firm market. The business is restricted for want of supplies. The opinion is that scarcely any fine can for a long period be expected, judging from the different parcels that have lately been imported being so inferior, confirms the previous reports from Singapore, that there was a good stock of middling, mixed, and low qualities, but no fine, and very difficult to be obtained.

June 26, 1862. Wm. Kirkmann,

4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	25 to 30	——
20	Do. B 7 per cent. till 1862 .	all	18 to 20	——
20	Do. C. „ „	all	9 to 11	——
10	London & S. of Ireland Direct.	2	— —	——
Stock	Electric Telegraph . .	100	100 to 103	——
5	London District Telegraph .	4¾	3¾ to 3¼ dis.	——
10	Mediterranean Extension Tel.	all	3½ to 4½	——
20	Red Sea and India Telegraph	all	18½ to 19½	19½
1	Submarine Telegraph, scrip.	all	⅜ to ½	——
1	Do. registered . . .	all	⅜ to ½	——
10	Do. „ . . .	all	4 to 6	——
2	Telegraph to India . .	1	¼ dis. — par.	——
5	United Kingdom Telegraph .	8	2 to 1 dis.	——

Recent Patents.

2725. W. Cook, Brixton, and H. Cook, Manchester, "*Printing telegraphs.*" Dated 30th October, 1861.

This invention consists in preparing the paper upon which the message is printed with salt of manganese.

2755. T. Walker, Chelsea, "*Cables or chains for telegraphic and other purposes.*" Dated 2nd November, 1861.

This invention consists in using pieces of iron or other metal pipes, and joining them together with certain joints, so as to form a continuous chain of any desired length; by passing an insulated telegraphic wire or wires through the pipes, communication can be effected and continued across rivers, seas, oceans, or other places.—*Not proceeded with.*

2784. G. T. Bousfield, Loughborough Park, Brixton, *Electro-plating or depositing metals.*" A Communication. Dated 5th November, 1861.

This invention consists in the employment of a solution of fused cyanide of potassa of great strength, in connection with a powerful galvanic current, whereby the patentee is enabled to plate iron and other metals rapidly and economically with copper, without the employment of either sulphate of cyanide of copper, and without danger or inconvenience to the workmen.

2991. W. Clark, Chancery Lane, London, "*Improvements in the construction of parts of electric telegraph belt apparatus, and in apparatus used in making the same.*" A Communication. Dated 27th November, 1862.

This invention cannot be described without reference to the drawings.

2997. H. Wilde, Manchester, "*Improvements in magneto-electro telegraphs, and in apparatus connected therewith.*" Dated 28th November, 1861.

The first part of this invention cannot be described without reference to the drawings. The invention consists, secondly, in certain improvements in the method of submerging uninsulated metallic cables, which greatly diminishes the risk and loss when by any accident such cables break in deep water and cannot be recovered, and which method also renders the cables less liable to injury after being submerged. In this improvement the uninsulated cable to be submerged is divided throughout its entire length into a suitable number of longitudinal sections, which form separate cables; each section is then separately submerged, and the extremities of all the sections are collected together at each shore end and joined so as to form one conducting cable.

3015. E. Tyer, Old Jewry Chambers, London, "*Electric Telegraphs.*" Dated 29th November, 1861.

This invention has for its object improvements in electric telegraphs, and relates to an improved arrangement of magnetic armature and electro-magnets, which arrangement is applicable to numerous useful purposes in

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electro telegraphy. Now in this improved arrangement the permanent magnet or magnets are stationary, and, consequently, may be made much larger and more powerful than when moveable on an axis. An iron ring is mounted on an axle, and placed in close proximity to the permanent magnet, so as to become magnetic by induction. Two openings or notches are made opposite each other on the periphery of the iron ring about half way through, and two very fine saw cuts through the remaining metal, thereby separating the ring into two distinct portions, but with the extremities almost in contact; the full effect of the induced magnetism is thereby concentrated at these openings, it being well known that, the closer the poles of a permanent magnet are brought together the greater will be the attractive force exerted. The horns or projections usually fixed to the electro-magnets are made in such form as to fit between the openings or notches made in the soft iron ring—in fact almost filling them up again, the distance or space left being regulated by the amount of oscillation required to work the particular instrument to which this arrangement is to be applied. Thus the full and combined effect of the permanent magnet and the electro-magnet is obtained, a very feeble current being sufficient to produce the oscillatory or vibratory motion required. Another part of the invention relates to certain arrangements of wheel work, whereby the oscillatory movement of electro-magnetic apparatus imparts a rotatory movement to a wheel, the axle of which, carrying an index or hand, points in succession to the letters of the alphabet or other signs engraved on a fixed dial plate, the object contemplated being greater rapidity in the working this class of instrument without tripping or over-running. For this purpose there is mounted on the axle carrying the index of a "step-by-step," or dial telegraph, two discs, pierced near their peripheries with a number of small holes arranged in a circle; an arm, carrying two inclined or conical-shaped pallets oscillates between the two discs, the apex of one cone entering one of the holes, say, in the right hand wheel, while the opposite cone leaves the hole of the left hand wheel; by the repetition of this movement of the pallet the two wheels are caused to revolve on their own axle, and the pallets and holes are so proportioned that, for each movement of the electro-magnetic apparatus, the index or pointer makes a step forward of a certain fixed length. Another part of the invention relates to improved arrangements of commutators or communicators for step-by-step, or dial, or other telegraphs. For this purpose, in constructing a battery commutator, the patentee arranges the alternate contact surfaces in a circle in the following manner:—Two rings of metal are employed, one placed above the other, and insulated therefrom; one pole of the battery is connected with the upper ring, the other with the lower. The upper ring is pierced with half as many holes as there are signs to be indicated on the dial plate (if the instrument is to be used with a step-by-step or dial telegraph), and within these holes, but not touching their edges, are placed metal studs screwed into the lower ring, and so formed that their upper ends come flush with the surface of the upper ring; a series of alternate contact surfaces will thus be presented, the studs representing one pole of the battery, and the intervening metal spaces the other pole. An upright shaft is fixed in the centre of the rings, and two insulated springs are caused to revolve round this centre over the upper ring, and to press on the alternate contact surfaces below. During the revolution of the springs the current from the battery is constantly being inverted, and, passing along the springs, enters the telegraphic circuits and instruments in connection therewith. Another improvement in the commutator or communicator of step-by-step dial telegraphs relates to the arrangement of the stops or finger keys which, when acted on, arrest at the proper time the flow of the electric currents into the telegraph's circuits, and consists in arranging them into two sets, one at each end of the commutator, and in parallel rows across the face thereof, instead of in a circle or in one longitudinal row, as heretofore. By this arrangement both hands can be employed with greater facilities, and the letters or sign engraved on or near the finger keys formed with greater accuracy by the manipulators. Another improvement consists in a modification of the commutator described by the present patentee in the specification of a former patent, dated 21st December, 1855 (No. 2895). The commutator therein described is so arranged that the outgoing current is directed through one instrument or indicator, and the incoming current through another instrument or indicator; the whole arrangement is there shown mounted on a base board, forming one complete instrument. Now, in the present improved commutator, whilst the principle before described is retained, the constructive details are much altered, and additional advantages secured. The improvement consists in mounting these commutators in two separate portions, the arrangement for the incoming current, together with the battery connections, forming one portion, and the pistons and connecting plates for the outgoing current the other portion. He prefers mounting the former on the back of the instrument case, and the latter on the door of the case, in such manner that, whenever the door is opened for the purpose of examining the instrument, the line circuit for the incoming current remains undisturbed, and signals can be received on the instrument or indicator; and upon closing the door of the instrument case, the pistons and connecting plates attached, forming the second portion of the commutator, come into position in order to transmit the outgoing current. Another part of the invention relates to improved arrangements of magneto machines especially applicable to dial telegraphs. For this purpose, he mounts two nearly semicircular permanent magnets upon a framework, so as to form a wheel, of which the magnets are the periphery; in this periphery, however, two breaks or spaces occur, the two magnets not being allowed to come in contact the one with the other. This magnetic wheel is capable of turning freely round a fixed shaft as a centre, and it has four horns of soft iron fixed to the poles of the magnet, so as to project radially from the wheel; these horns, as the wheel revolves, pass over the ends of the iron cores of a series of electric coils, arranged in a circle, and mounted on an iron ring, which couples them all together. As the horns pass in succession over the poles of the electric coils, induced currents, alternately positive and negative, are thereby generated, and flow into the telegraphic circuit and instruments, short springs and contact pieces being employed in order to shut out of circuit those coils not in use at any given time during the revolution of the magnets. Another part of the invention relates to improved arrangements for supplying ink to printing telegraphs. For this purpose he employs a strip of metal having a channel with under-cut grooved sides along its entire length; this is mounted on a pivot in a slightly inclined position near the periphery of the ink roller, which serves as the marker of the printing instrument. Within the grooves is inserted a piece of cloth, saturated with ink, one end hanging over and resting on the ink roller; the other end likewise hangs over and serves as a reserve, so that, when the first end becomes dry and clogged, by simply sliding the cloth along the groove, and cutting off the clogged end, a new surface is presented to the roller. Another part of the invention relates to improvements in galvanic batteries, and consists in placing a flat saucer-shaped vessel at the bottom of each of the cells of a battery; a gutta-percha covered or otherwise insulated wire is fixed to the saucer, and the point of it from which the insulating material is removed, is caused to project about one-sixteenth of an inch to the interior of the saucer; the wire is bent up, taken out and over the top of the cell, and connected to the negative metal of the next cell, passing through a bar of wood, to which the negative metal is attached by a dovetailed wedge; a plate of zinc is laid at the bottom of the saucer, and a small quantity of mercury poured in, so that the zinc floats on the surface of the mercury; the mercury preserves perfect contact between the zinc and the wire connected with the negative metal, and all binding screws, terminals, and clamps are dispensed with, and local action prevented.

8076. B. W. Gerland, Newton-le-Willows, Lancashire, "*Manufacture of sulphate of copper and other salts of the same metal.*" Dated 7th December, 1861.

The patentee claims, first, the manufacture of sulphate and other salts of copper from that description of ore known as malachite; secondly, the use of malachite or other carbonate of copper, and also of oxide of copper for precipitating iron and other metals from cupreous solutions.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

TEXTS FROM THE BLUE BOOK.—No. 2.

To the Editor of The Electrician.

"That the interposition of a viscid insulator between two coatings of gutta percha, neither decreases the induction, nor improves the insulation of the line. If Mr. Hughes's process should possess any advantage, it will be found in the tendency of the viscid fluid to fill up air-holes or flaws in the gutta percha coatings."—*Government Report*, page xxii.

Sir,—Thus, in three lines and three-quarters is Professor Hughes's unique invention disposed of. Curt, caustic, categorical is the text; and just sufficient to excite the curiosity of the not over-curious. Respecting the viscosity, and other remarkable qualities of this semi-fluid, the humble scribe now addressing you confesses to an amount of curiosity that would do no discredit to the fairest of Eve's daughters; but, unlike that peerless part of creation, I have not, at present, even the ghost of anything to gratify it: this is provoking. I am baffled at the outset. How am I to preach, save, to a certain extent, on conjecture and supposition? for the matter is encircled by *cheveaux-de-frise* of impenetrable mystery, which, I presume, only Professor Hughes himself can remove, but none the less adapted to arouse the irascibility of the most painstaking book-worm, or the hieroglyphic and syballitic groper; and yet I persist in asking myself (just as if I could enlighten the querist upon the point), what is this viscid substance, which "neither decreases the induction nor improves the insulation," and yet is suitable for filling up "air-holes and flaws in the gutta percha coatings?" Parenthetically, the text, in its latter part, seems to me to contradict the former; it (the fluid) *does* improve the insulation, and it *does not*. But stay, a thought has just struck me: suppose we have recourse to the evidence of Professor Hughes (Blue Book, pages 85, 86), perhaps this will throw some light on it; there is a chance that we shall find out its constituents, and the relative proportion of the component parts, the intermingling of which produces this singular and extraordinary insulating substance. But let us not be too sanguine. Do you think I shall let the world into the secret of the elixir of life when I make the discovery? It is not likely. Then don't be chagrined if, after all our

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trouble and research, this matter remains as great a riddle as the sphinx. Hoping, however, to come to it in due time, let us proceed. We find (2046) that where this semi-fluid is an element in the insulation of a wire it is endowed with the faculty of turning up in the most unaccountable manner, and in the most unlooked-for places, and when you think you have him safely buried underneath, he suddenly makes his appearance like far-famed John Barlycorn, and practically says: "If this gutta percha had been properly put on I should not thus have shown my face; I am here to make up for the short-comings of my neighbour." Well, this is certainly a very commendable quality, and one rarely to be met with. Which of your kind neighbours, I should like to know, will provide the needful for your "three months after date I promise to pay," &c. falling due next week, and not a stiver in your exchequer. And further (2050), this inimitable preparation does not insist upon his "pound of flesh" in consideration of the service rendered. No, no; on the contrary, he is the kindest of all neighbours (by the way, should not I use the feminine pronominem? and yet, on second thoughts, no; since it will not dissolve gutta percha, nor mingle with it, and we know very well that the feminine *can* dissolve the masculine into utter nonentity, and mingle with him so perfectly as to leave not a trace of his original element); for if the percha be in a shaky condition, rotten or what not, this good Samaritan literally pours balm into his wounds, hugs him in a warm embrace, and restores the bloom of his youth; or, in the words of the lucky inventor, "you can restore old gutta percha by this semi-fluid." In fact, it does more than that, it gives it (the percha) a hard and flexible appearance, which it never before possessed, not even in its pristine condition. Disinterested, noble, generous, wonderful. Hallo! what's this? (2052)—"Its compound parts are a secret." "Patented?"—"Yes."

"So farewell hope, and with hope, farewell ——."

Now, if I had been one of the committee, I should, if I had felt so disposed, have been privately informed all about the very thing for which I have been so long fishing in vain; but as I do not belong to that privileged body, I suppose I must chew the cud of disappointment as philosophically as possible, and recommend you, my friends, to do the same; in the meantime I proceed with my discourse.

We have seen how gutta percha, in the last stage of existence, can have more than all its hey-day virtues restored by this wonderful element; in continuation, I may inform you, on the testimony of Professor Hughes himself (2055), that the insulations, by means of gutta percha thus vigorously renovated, is precisely *four times* superior to the best gutta percha, minus this viscid revivifier. There, what think you of that? It is something considerably more than sticking-plaister, say what you will.

Why, if that gentleman (?) who so disinterestedly drove the nail into the cable had had a wire insulated in part with this semi-fluid to contend with, the probability is, that his praiseworthy efforts to destroy the cable would have been rendered abortive; it is ten chances to one that the fluid would have rushed to the rescue, summarily expelled the tenpenny, filled up the vacuum, saved the contractors some few thousand pounds, and have rendered it unnecessary that recent legislation in a certain direction should bear the odium of shielding a criminal from the punishment he so justly merited.

But the insulation—puncture it, twist, bend, break, or otherwise maltreat it, here is the palladium—the heal-all—in fine, the life and soul of an otherwise dead cable, and all this may be secured at an extremely moderate figure—it is cheap. Is not your curiosity stimulated to know something more of this miraculous, wonder-working agent—this semi-fluid of a treacly consistency (but not by any means sluggish on that account), which thus rushes with such ardent zeal to hide another's faults? Would that I could gratify you; that I could catalogue its constituent elements, as well as its effective virtues.

Pardon my prolixity, I see I have not finished the chronicle of its excellencies. Briefly, then, (2059) it never becomes solid, nor does it mix with water, and, though you boil it, it shall not increase its fluidity, neither shall an icelandic winter freeze it into rigidity; and what if the wire do become eccentric and elbow its way through the gutta-percha coating, this viscid insulator will stick to it like a leech, and insist upon the conducting wire keeping on its nether garments, whatever he may do with his coat; and (to sum up with a staggerer) this nether garment of unparalleled viscosity never becomes bad!

I was just on the point of closing this unsatisfactory discourse when I accidentally opened at the evidence of Mr. Latimer Clark. I shouted, "Eu—r-e-k-a!" (The latter part of the word inaudible, for *I had not* found it.) It seems to me that Mr. Latimer Clark could tell us better what it is not, than what it is. I fear it is guess work on his part; perhaps the result of some unsatisfactory chemical analysis. Anyhow, this gentleman does not seem a vast deal wiser than you and I, as to its component parts; and it would seem also from this, that our ungrateful Government Committee did not avail themselves of the magnanimous offer of its patentee, to be privately let into the secrets of its contents and composition. Here it is, however, *verbatim et literatim*; so cherish the choice morsel:—

(3611). "It is a kind of tar prepared in the distillation of a peculiar sort of anthracite coal, or shale, used in Scotland for making gas; it contains no naptha."

With all its virtues, however, I cannot but think the Government Committee acted wisely in throwing the wet sheet over it; but how they could come to the conclusion that it neither decreased the induction nor improved the insulation, I cannot make out. The experimental tables of the report certainly show it superior to gutta percha in these respects, and it is undeniable that the evidence, meagre though it be, is of the same character. It would have been more satisfactory, therefore, if the committee had favoured us with a cause for its non-recommendation more in conformity with the true state of the case.

The evidence of Mr. Latimer Clark is corroborative of all the superior qualities claimed for it by its inventor, and we may safely accept such testimony; nevertheless, I join issue with the Government Committee in its rejection, but on different grounds, and from what I conceive to be its greatest, and perhaps its only defects, *i. e.*, its semi-fluidity; such insulating substances, however serviceable for a time, must in the end prove pernicious. Moisture of whatever description is the very thing to be avoided, unless you wish a process of oxidation, and consequent decomposition, to ensue. Certainly, it would seem an almost indispensable substance where gutta percha is used as the insulating agent, since the die process of application never can ensure indemnity from air holes and other similar defects, but for the matter of that the cable may as well come to grief one way as another.

But all holdings-forth are supposed to convey a lesson. What, then, is the moral of the foregoing? evidently this, that it is unwise to use any material as an insulator which requires to be patched up with some other adjunct, in order to render it serviceable: substitute india rubber for gutta percha, and then no man need ransack his brains and "search from Britain to Japan," in order to find a remedy for a defect which will then have no existence.

AMICUS.

Miscellanea.

PRESERVATION OF FOOD.—One of the most curious and valuable illustrations of preservative methods as applied to meats is shown in the Exhibition, by Messrs. Jones, who exhibit under common glass shades legs of pork, lamb, salmon, &c., and, in short, all the viands which are the most difficult to keep from tainting. Some of these specimens have been in the annexe since a week before the opening of the Exhibition, and the portions removed within the last few days to be cooked and tasted by the jury were found to be absolutely perfect in their freshness. The process, we believe, simply consists in exhausting as much as possible of the air from the case in which the meat is placed, and then completing the vacuum by the introduction of sulphuric acid in minute quantities, after which nitrogen gas is allowed to fill the case, to the total exclusion of oxygen, without the presence of which no decomposition can go on. Chemical truths are almost as infallible as mathematical truths, and there is no known reason why meat thus protected should not remain good for years as well as months.

To Correspondents.

J. COOK.—The effects of the coil are not due to static induction, but to magneto-electric and dynamic induction. In this case, therefore, the conductivity of the wire *does* influence the inductive effect in the primary wire, because the current is less powerful with a wire offering greater resistance, and in the secondary, because, though the intensity remains the same, the quantity of electricity in the discharge is diminished. A perfect degree of insulation in the coil is the most essential point, and it is only when this is obtained that the advantage of keeping the layers of secondary wire as close as possible to the primary can be realized.

L. L. S. (Cuckfield).—The cells lose their porosity by deposition of copper. If moistened with a solution of common salt, to which a little sulphuric acid has been added, and exposed to the air, the copper may be removed. The porous vessels should never be allowed to dry when once in use, unless the copper salt has been thoroughly removed from the pores, otherwise they are liable to disintegration. In the electric kite experiment the metallic cord might be simply wound upon a stout rod of glass fastened to two uprights of wood fixed in the ground, and furnished with a winch handle. A conducting wire, or knob, should be in proximity to the cord, and may be connected either to earth or to a Leyden battery, so arranged as to be discharged when the accumulation has reached a certain point. You must be careful to have such a conductor constantly in much closer proximity to the wire than the hand of the experimenter, otherwise serious results might occur from an unusually strong discharge, even while no storm-cloud was actually overhead.

IGNORAMUS.—Were the copper negatives mentioned in your communication kept for any considerable period in a charged cell while the circuit of the battery was broken? If so, either the impurities in the copper elements, or those of the copper solution might have brought about the result you mentioned. We have never observed the phenomenon in the case of a battery in which the circuit had been completed so as to produce a deposit of pure copper upon the negative elemen

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The Electrician.

VOL. II. No. 35.—JULY 4, 1862.

CONTENTS:

	PAGE		PAGE
Automatic Telegraph Instruments	97	International Exhibition	102
Some Considerations on the Principles of Electrical Conduction and Accumulation	98	The Physical Geography and Hydrography of the Arctic Regions	103
Application of Ohm's Law in the Production of Electro-Magnetic Effects	100	Prices Current of Insulating Materials	106
Testing Cables	100	Colonial and Foreign Telegraphy	106
An Electric Telegraph in the Year 1815	102	Telegraphic News	107
The Student	102	Correspondence	107
		Miscellanea	108
		To Correspondents	108

AUTOMATIC TELEGRAPH INSTRUMENTS.

THE value of the original idea of Professor MORSE in the construction of his electro-magnetic telegraph is becoming generally recognized now that the difficulties which beset the early inventors of signalling instruments have been for the most part overcome. The idea in the abstract was to render the transmission of dispatches, when once arranged and "verified," or corrected, independent of any but mechanical agencies. The method of carrying this out which was then adopted is so simple and ingenious as to render its employment by no means inapplicable, even at the present day. The letters of the alphabet were represented by types formed of pieces of metal, with notches at various intervals. These types were set up in a frame-rule, and passed beneath one end of a lever, which, when raised by the projecting portions of the type, completed the battery circuit by means of wires dipping into mercury cups, and attached at the other extremity of the lever. At the receiving instrument dots and dashes corresponding to the raised portions of the type were produced upon paper. Although this system was found to be inconvenient—owing to the defective mechanical appliances by which it was carried out, and was superseded by transmission with the lever key, it possesses most of the advantages which are now sought for in automatic systems of transmission. The operation of sending signals by hand is necessarily, in most cases, much less rapid than mechanical transmission, and, besides requiring a considerable amount of experience and attention, is always attended with occasional mistakes, necessitating the repitition of the faulty portion of the dispatch. What is required for speed, accuracy, and facility of signalling, is a system wherein human labour and intellect bestowed upon the mechanism of the instruments may obviate, as far as possible, the necessity for their employment in the practical working of the telegraph. The desideratum was in no mean degree attained in MORSE's original contrivance; for the setting up of the types was little more than a mechanical operation, necessitating on the part of the compositor no stretch of memory, and allowing full time for revision and correction. Indeed, in this respect it appears more perfect than most of the modern systems, in which the compositor, instead of picking up a type from its proper partition, is called upon to signify a letter by an arbitrary combination of signs, requiring some exercise of the faculty of memory.

Mr. ALEXANDER BAIN appears to have been the first to employ a perforated strip of paper for the automatic transmission of signals. One perforating key only was used, by means of which holes were punched in the strip, representing the dots and dashes of the MORSE alphabet—the dashes being formed by several successive perforations. The perforated strip, passing between a spring and a cylinder, was made to interrupt the circuit, except when contact occurred through the apertures; the current then reproducing the dots and dashes by electro-chemical action at the receiving station. In regard to this plan, it is to be observed that the perforation of the paper was a lengthy process, owing to the number of strokes of the key necessary to produce the signal for a letter. It is stated, moreover, that the intervals between the perforations were frequently burnt away by the action of the spark on breaking contact, a result which might certainly follow from the use of high battery power, but which appears somewhat difficult to account for under ordinary conditions. The friction of a spring upon the paper, probably contributed in greater degree to the destruction of strips when these were repeatedly sent through the transmitting instrument. In the automatic transmitter of Mr. ALLAN, this friction, and the effect of the spark, have been effectually guarded against by employing a rotating spur wheel, the projecting points of which form a very perfect contact through the holes punched at regular intervals in the paper.

We may here notice an ingenious modification of the original plan of Mr. BAIN by MM. DIGNEY, of Paris. Instead of causing the contact to be made directly by means of the spring, or piece of metal passing over the perforated paper, they give to this merely a mechanical function. A groove is made on the cylindrical surface upon which the paper moves, immediately below the apertures; so that the piece of metal, which forms one end of a lever, may move through a space considerably greater than that corresponding with the thickness of the paper. The contact is made by a flexible spring attached to the other extremity of the lever. We shall have occasion to compare some of the arrangements in the instrument for automatic transmission of MM. DIGNEY, with those adopted by Professor WHEATSTONE and Mr. ALLAN.

In regard to the contrivances for preparing the slips for transmission, the most perfect is undoubtedly that of Mr. ALLAN, by which the combination of dots representing a letter is punched in the paper by one stroke of a lever corresponding to the letter in question. The method by which this is done is very ingenious; there being, if we remember rightly, but eight or ten separate punches in the instrument. Professor WHEATSTONE employs three keys, of which the two outer ones move in conjunction with the inner one, the latter however being capable of independent motion. Several strokes of these levers are necessary in producing a letter, and moreover the spaces have to be marked out by means of the inner key. In the perforator of M. M. DIGNEY, by which holes are punched corresponding to the dot and the dash of the ordinary MORSE alphabet, two levers are used, one of which serves merely to move the paper slip. In a practical point of view this system is very imperfect, owing to the tediousness of an operation in which a considerable number of strokes of the two levers is required to produce one letter—more than one stroke being necessary for the dash alone, and several for the spaces between the signs, letters, and words—and also from the liability to error. The only perforating instrument we have seen which can lay any claim to be considered automatic, is that of Mr. ALLAN.

The ingeniously contrived alphabet of Professor WHEATSTONE, in which the dot and dash of the MORSE alphabet are represented by two similar signs on opposite sides of the paper strip, possesses in our opinion a serious disadvantage in rendering inapplicable the method of working by reverse currents, which we have already referred to,* as applied by Mr. VARLEY on the lines of the Electric Telegraph Company, and which forms a distinguishing characteristic of Mr. ALLAN's system. Leaving out of the question the comparative merits of the make-and-break and the reversal methods of working in signalling through long submarine wires, it is obvious that an immense advantage is obtained by the electro-magnetic relay adapted for the reversed currents. In the WHEATSTONE recording instrument, the electro-magnets are required to overcome the force of the light springs which restore the wire pens to their normal position when the current ceases. In ALLAN's relay, which is self-regulating, the magnets have only to overcome the inertia of the moveable piece of soft iron, by means of which the circuit is completed, and the signal become

* Page 130, Vol. I.

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printed. The difference of the two arrangements, in point of sensitiveness, is very considerable. It need scarcely be stated that the objection to the spring relay, or similar contrivance for printing direct, applies in all cases where the line is worked on the make-and-break system, and that the frequent reversals of the current in Professor Wheatstone's system do not in any way facilitate the adoption of a different principle in the recording apparatus.

A high degree of mechanical delicacy in a relay becomes comparatively useless when the contacts are liable to become defective, which is always more or less the case when the spark occurs in the relay on breaking contact. We can scarcely sufficiently admire the contrivance by means of which Mr. Allan transfers the spark from the relay to a portion of the receiving instrument, where its effect is of much less consequence. After the relay has completed the circuit of the local battery, this circuit is broken in the recording instrument while the signal is being printed; and a fresh signal can only be printed by means of a current traversing the relay in a contrary direction. Thus the points of contact in the relay are preserved from the disintegration and oxidation produced by the voltaic spark.

We are not aware that any system of automatic transmission, embodying the method of working by reverse currents, has yet been devised which is applicable to the Morse instruments in actual use. In France, where the make-and-break system is universally employed, it is probable that the automatic recording instruments of MM. Baudonin and Digney will come into general use. In this country innovation may be looked for in several directions; but it appears that for a long time past we have at our disposition a mode of signalling which is universally applicable, and which in its essentially automatic character, its rapidity, and its correctness, will not easily be surpassed. We have given with some amount of reserve a few of the data upon which our conclusions are based in favour of Mr. Allan's instruments, and we can scarcely doubt that these conclusions will receive additional confirmation by the forthcoming awards of Her Majesty's Commissioners for the International Exhibition. We have nevertheless a sufficient amount of diffidence in our own conclusions, and of reservation in regard to those of others, when arrived at from a simple inspection of such marvels of constructive skill and ingenuity in applying electrical agencies as are now shown at Kensington, to admit the expediency of collecting, under adequate supervision, the data which would be furnished by a practical trial of various instruments and systems of electrical signalling on a sufficiently extended scale. This is what the centralizing system of our French neighbours enables them to do from year to year; but in our case an investigation extending over a comparatively short space of time would be sufficiently useful and instructive without interfering with the predilictions of those who are supposed to be the best judges of the telegraphic instruments and systems adapted to their particular use—viz., telegraph manipulators and telegraph companies. The practical nature of the test would render easy what is otherwise a somewhat invidious task, and would either disprove or cause to be recognized, claims which we believe in most cases to be *bonâ fide*, but which in most cases also are contradictory to each other. The cheapness and efficiency of our telegraphic system are matters of public moment; and the opportunity should be rendered available to perfect these conditions upon adequate and unquestionable experimental data. In most cases, as we have already inferred, we believe that telegraphic inventors and patentees would gladly submit their systems to the ordeal of experimental investigation and practical trial; albeit the conclusion to be arrived at could scarcely be favourable to more than one of these systems.

The articles entitled "Steps to Theory by the Practice of Electricity," which have appeared in our leading columns, are for the present brought to a close. To a certain class of readers, the tendency of whose mind is to look for more than the proximate causes of effects, and whose endeavour is to obtain an insight into the operation of natural laws, which may enable them clearly to trace the origin of phenomena and to refer all phenomena to their natural system of causation, the essay embodied in the above will have been perused with some degree of profit. We anticipate that some time must elapse before the importance of the theoretical conclusions we have endorsed, or even their distinctive character, can become generally recognized. We are convinced, however, that they afford the true elementary principles upon which the electrical theory, which alone can be competent to satisfy the mind, and to fulfil in a practical point of view what is required of it, is to be based. We recommend the essay, therefore, to the careful consideration of electricians who desire to base their practice upon correct theoretical data, and the endeavour shall not be wanting on our part to extend, in various directions, where the application of theory may be most beneficial, the bearings of the main facts we have arrived at.

We desire to make the following correction in the reading of the article in our last number:—

ERRATUM.

Par. 306, from eighth line read, "secondly, by increasing the number *simultaneously with the dimensions* of electromotive elements worked in series, by which also increased quantity of electricity is furnished and delivered over to the coil in a given time to pass through it in the form of a more voluminous or denser current; and thirdly," &c.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 89].

Professor Faraday's experiments also show that if two or three charged spheres be introduced into the insulated shell B, the total quantity on the exterior of the shell B, produced by its polar state, will be exactly equal to the sum of the charges of all the spheres.

Thus he says: "if in place of one carrier, many carriers in different positions are within the inner vessel, there is no interference of one with the other; they act with the same amount of force outwardly, as if the electricity were spread uniformly over one carrier, however much the distribution on each carrier may be disturbed by its neighbour."

It must, however, be clearly understood and borne in mind that the polar state of the shell B is dependent on the conditions under which the interior sphere or spheres are charged, and is not simply the inevitable result of its containing these charged conductors.

The following are some of the conditions under which the polar state of B will result:—

1st.—By charging the interior sphere A from one pole of a source, having its other pole connected to the surrounding objects; then insulating A, and introducing it into the shell B (as in fig. 9).

2nd.—By charging the sphere A when exterior to B from one pole of a source, having its other pole connected to another conductor exterior to, and insulated from B, and then insulating and introducing A into B.

3rd.—By connecting A, before it is introduced into B, with a charged conductor exterior to B, then insulating A, and introducing it into B.

4th.—By charging the sphere A after it is introduced into the shell, from one pole of a source, having its other pole connected to the surrounding objects, as in fig. 10.

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5th.—By charging the sphere A, after it has been introduced into B, from one pole of a source, having its other pole connected to a conductor, exterior to the shell B, as in figs. 17 and 18.

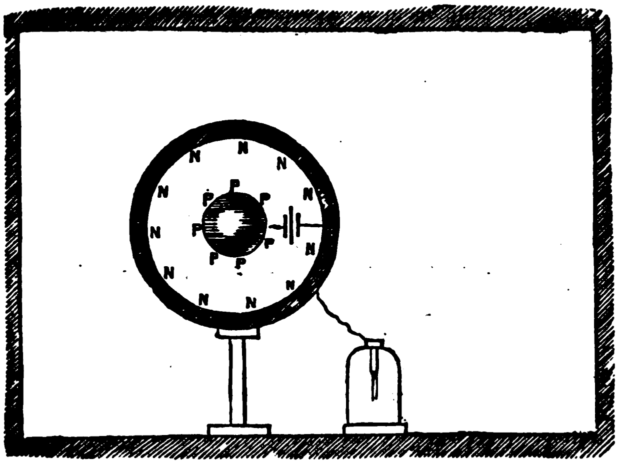
6th.—By connecting A, after it is introduced into the shell B, with some charged conductor, by means of a wire passing through an aperture in B.

It will be seen that in any of these cases the exterior surface of the shell is either comprised in the inductive circuit that causes the charging of the sphere, or else is situated between A and some surface on which the opposing charge to that on A must distribute itself.

By any of these means the polar state of the shell will be brought about, and the charge on the exterior of the shell will be exactly equal and opposite to that on its interior, and exactly equal, and similar to that on the charged sphere within it; and if, therefore, the charged sphere is taken out of the shell without touching the latter, then the polar state of the shell will entirely disappear by the recombination of the equal and opposite charges on its interior and exterior.

If, however, the sphere A, being inside the shell, be charged from one pole of a source, having its other pole connected to the shell, then no polarization of the shell can ensue; the whole action being confined to within the interior of the shell, as represented in fig. 11.

Fig. 11.



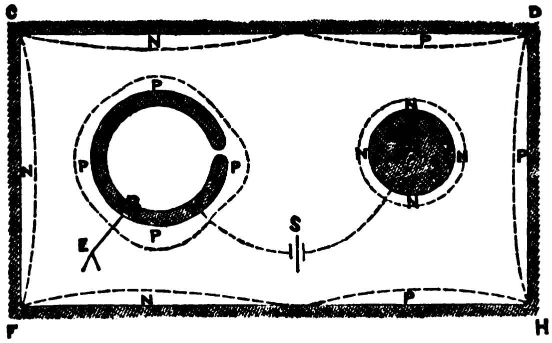
For the inductive circuit may be thus traced from one pole of the source to the surface of the sphere, and thence across the dielectric to the interior surface of the shell, which is in communication with the other pole. The exterior surface of the shell is not comprised, therefore, in the inductive circuit. The interior surface of the shell will therefore become charged with an equal and opposite quantity to that on the sphere A, whilst the exterior surface will be perfectly neutral.

The electrical state within the shell would thus be precisely the same as if the sphere A had been charged with the same quantity, by any one of those means I have pointed out as being capable of producing the polar state of the shell; but the state outside the shell would be entirely different, being entirely neutral, instead of having a charge on it equal to the charge on the interior sphere.

Again, if the sphere A, being exterior to the shell B, as in fig. 75, be connected to the negative pole of a source S and the shell B to the positive pole; then the charges on each will be equal and opposite to that on the other. These charges would be the result of, and sustained by, partly the direct induction between A and B, and partly by indirect action through the polarization of the surrounding surface, C D F H.

A portion of the surface round A would therefore be positive, and an exactly equal quantity of negative would be induced round B; and the distribution would be that shown in the figure. If the sphere A (the source being withdrawn) be now placed within the shell B (B remaining insulated), the whole of the charge

Fig. 75.



on the exterior of the shell will pass to its interior, the equal and opposite induced charges on the surrounding surface at the same time recombining and reducing all outside the shell to the neutral state, and the distribution will be the same as that shown in fig. 73.

If the sphere A is charged in any way exterior to the shell B, and then introduced into the shell whilst the latter is connected to the surrounding objects; then when B is insulated, it will not be in a polar state, and will have no charge on its exterior; or if B is connected to the surrounding objects, and the sphere being placed within it be charged in any way, then when the shell is insulated it will not be in a polar state.

In all these cases, where no polar state is produced in the shell, by the charged sphere within the shell, it will be seen that as the interior of the shell has a charge equal and opposite to that on the sphere within, whilst the exterior is neutral, if the sphere is taken out without touching the shell, the charge on the interior of the shell will pass to its exterior; this action being sustained partly by direct inductive action between the exterior of the shell and the sphere, and partly by the indirect action through the surrounding surface. The distribution would then become the same as that represented in fig. 75.

The surrounding surface will become polarized; that is, one portion surrounding B will be in an opposite state to B, and the other in an opposite state to A, these induced quantities being themselves equal and opposite, but less than the total charge on either of the conductors, by just that amount of those charges which is maintained by the direct action between A and B. See also fig. 15.

It may be said, therefore, that the conditions which will allow of the charged sphere A to be within the shell B, without any electrical effect being produced exterior to B, are those which communicate to the shell B a permanent charge equal and opposite to that of the sphere A.

Numberless other problems of distribution and redistribution might of course be given, but sufficient examples have been given to illustrate the general principles, according to the reading I have taken, and which entirely dispenses with the necessity of considering "the earth as a common reservoir, to which all free electricity must return," &c.

The explanations I have given of the action that takes place with a pair of condensing plates, &c., will be found equally correct, therefore, if applied to the same experiments when performed in an insulated room, whereas the explanations given in all hitherto published works would in such case entirely fail, since they all depend at some part of the action on a flow of some of the electricity to the "indefinitely large surface of the earth."

(*To be continued.*)

2925

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ON THE APPLICATION OF OHM'S LAW IN THE PRODUCTION OF ELECTRO-MAGNETIC EFFECTS.

BY PROFESSOR JACOBI.

THE power in electro-magnetic machines is produced and maintained, as is well known, by the action of the voltaic apparatus. By using zinc as a positive metal, copper as a negative metal, and water acidulated with sulphuric acid as the conducting liquid, it is the transformation of the metallic zinc into sulphate of zinc which here constitutes the cost of keeping the apparatus in action. It is a matter of the greatest importance to reduce as much as possible this cost. Let us examine what is the relation between the magnetism of the connecting wire and the action of the voltaic apparatus. Since the discovery of electro-magnetism this object has engaged the attention of distinguished scientific men; but it presents so many difficulties, and such a complication of circumstances, that we cannot be surprised that the theories and formulæ which they have endeavoured to deduce from experiments differ considerably.

This is not the place to enter into the criticism of these theories; but it appears to me that the theory established by M. Ohm, in a little work entitled "*Die galvanische Kette, mathematisch bearbeitet von Dr. G. S. Ohm* (1827)," and developed more fully in various memoirs printed in the German journals, presents so much simplicity, and agrees so well with all the phenomena of the voltaic pile, that I have not hesitated to adopt it, in order to obtain from it a general basis for the arrangement of the different elements of the magnetic apparatus. I may be permitted here to state the fundamental principles of this theory.

1. In a closed voltaic circuit the same quantity of electricity passes across each section which is perpendicular to the direction of the current, whatever be the form or the matter of the different parts of the circuit.

2. Whatever change is made in one part of the circuit, this change affects the entire action of the pile, and is not confined merely to the place where the change takes place.

3. The voltaic action, in whatever manner measured, is in the direct ratio of the electro-motive power, and inversely as the resistances which oppose themselves to the passage of the current, or $A = \frac{E}{R}$.

4. The resistances are composed of—

(*a*) The resistance of the solid conductor, or of the connecting wire. For the same substance this resistance is directly as the length of the wire, and inversely as the transversal section, or as its thickness.

(*b*) The resistance of the liquid conductor: this is in the direct ratio of the thickness of the liquid stratum which separates the positive and negative plates, and inversely as its transversal section, which coincides generally with the surface of the plates. During the action of the pile this last resistance increases, and at the same time the electro-motive power, or E, is affected by it. This is caused by chemical effects which take place and change by degrees the nature of the liquids, the surface of the metals, and the electric tension.* But fixing any state of the pile, the law cited always exists. The difficulty of making electro-magnetic experiments comparable with each other, and the still greater difficulty in obtaining absolute measures, consist principally in the continual change of these elements. Thus in expressing by r the resistance of the connecting wire, we shall have $\frac{r\,l}{d}$ for the resistance of a wire, of a length l, and of a thickness d; $\frac{r'\,l'}{d'}$ will likewise be the resistance of the liquid conductor, the surface and thickness of which are respectively expressed by $d'\,l'$. Therefore the action of the current, or the quantity of electricity passing through the pile, will be $A = \dfrac{E}{\frac{r\,l}{d} + \frac{r'\,l'}{d'}}$.

5. The electro-motive force is in the direct ratio of the number of voltaic pairs united in a pile, and at the same time the resistance r' increases in the same proportion. Having one pile of n' pairs, the force of the current will be expressed by $A = \dfrac{n'\,E}{\frac{r\,l}{d} + \frac{n'\,r'}{d'}}$.

6. If the electric current is divided into several branches, the lengths of which, reduced in an inverse ratio to their diameter, may be expressed by $l\,l'\,l''$, &c., the total action will be the same as if there were only a single connecting wire whose length is expressed by the equation $\frac{1}{L} = \frac{1}{l} + \frac{1}{l'} + \frac{1}{l''}$, &c. Therefore, having n wires of the same length, the total force of the current will be expressed by

$$A = \frac{n'\,E}{\frac{r\,l}{nd} + \frac{r'\,l'\,n'}{d'}} = \frac{n\,n'\,d\,d'\,E}{r\,l\,d' + r'\,l'\,d\,n\,n'}.$$

As we can avail ourselves of the magnetizing power of each unity of length of the connecting wire by coiling it round bars of the same dimension, the total power gained by a connecting wire l will be

$$A = \frac{l\,n\,n'\,d\,d'\,E}{r\,l\,d' + r'\,l'\,d\,n\,n'}.$$

From this formula the limits of the action of the current may be deduced, which cannot be increased by the number or the surface of the voltaic pairs, by the length, the diameter, and the number of the connecting branches. Increasing only the surface of the pairs d', the limit of the total power of the current will be $A = \frac{n\,n'\,d\,E}{r}$; increasing the number n', this limit is $A = \frac{l\,d'\,E}{r'\,l'}$.

Again this limit will be, by increasing the length of the wire l, $A = \frac{n\,n'\,d\,E}{r}$; the thickness of the wire d, $A = \frac{l'\,d'\,E}{r'\,l'}$; the number of the connecting branches n, $A = \frac{l\,d'\,E}{r'\,l'}$.

In general, in order to increase the force of the current to any degree, it is necessary to enlarge the surface of the plates, and at the same time the thickness of the connecting wire, or the number of the branches. The increase of the number of the pairs requires that of the length of the connecting wire, in order to attain the same end.

The experiments, as accurate as they are numerous, which M. Fechner has made on this subject, and which he has published in his work, "*Maassbestimmungen über die galvanische Kette* (1831)," leave no doubt as to the justness of these laws, which express in a very simple manner all the relations of the different elements which constitute the voltaic pile. These experiments have been made for the most part by employing the method of oscillations, which M. Biot was the first to apply ingeniously to this kind of experiments.—*Taylor's Scientific Memoirs.*

* This does not apply in the case of electro motors constructed on the principle of the Daniell cell.—ED. E.

TESTING CABLES.

THERE is no operation connected with the submersion and repair of submarine cables, which requires greater skill, more experience, and a more intimate knowledge of the laws that regulate that subtle force, electricity, than testing. It qualifies the engineer to become thoroughly acquainted with the electrical condition of the wire from end to end, permitting him to glance, as it were, along the rope, however deep it may be submerged, to learn its imperfections, and to know its condition. It enables him to direct his ship with almost unerring accuracy, to the spot where any failure exists. It gives him a confidence in his operations, which astonishes the uninitiated, and pleases the men employed under him, and it considerably reduces the expense of repairing cables. To give an idea f the accuracy with which testing can be conducted, it may be mentioned, that one occasion, the author pronounced a fault to be at 6 miles from Alderney, and that $2\frac{1}{4}$ inches of copper were exposed to the action of the salt water. The fault was ascertained to be exactly 6 miles off, and 2 inches of copper were found to be exposed. He has never been more than one mile wrong in his calculations, although the tests have been made at 5 miles, at 20 miles, and sometimes at 80 miles from the broken end. Messrs. C. F. Varley and G. Preece, have been equally accurate in the North Sea. On one occasion, Mr. Varley pronounced a defect in the Zandvoort cable of the Electric and International Telegraph Company, to be 61 miles from the English shore, and it proved to be at the exact spot indicated. Mr. G. Preece, in testing on board ship, 13 miles from land, while repairing a break at that spot, found the cable again severed at a distance, according to his tests, of 50 miles towards Holland, and the break was found at $50\frac{1}{4}$ miles.

Mr. Webb, in his Paper, has referred to and described his system of testing, but considerable improvement in instruments used, and in the manipulation required has been effected since that period. The study of testing has been generally neglected in the education of telegraphists, and little care has been taken by the companies, to keep a careful register of the electrical condition of their cables and lines.

The principles employed in testing may be divided into those dependent upon the laws of resistance, and those dependent upon the laws of induction. Resistance is the obstruction which materials offer to the free passage of electricity, and it may be said to represent both conduction and insulation. A perfect conductor is one which offers no resistance to the

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transmission of an electric current; a perfect insulator is one whose resistance to the passage of the same current is infinite. No absolutely perfect conductors and perfect insulators, however, are as yet known; and thus the perfection of an insulator, or a conductor, depends, at present, upon its amount of resistance. If a wire conducts badly, its resistance is great; and if an insulator conducts well, its resistance is slight. It is, therefore, easy to express the degree of insulation, or conduction of a substance, in units of resistance; and this is frequently done in practice. It has been usual hitherto in describing the condition of a wire or cable, to say that it gives a° of earth, with n number of cells; that is, that a current being applied to one end of a wire, and the other end being disconnected, its imperfect insulation, or faulty places, allowed a° of current to flow to the earth through a galvanometer. This a° is supposed to represent the insulation of the wire. It gives an approximate idea of the condition of the wire to the electrician who manipulates his own instrument, but to convey to others the state that a° represents, it is necessary to describe the instrument employed, the power used, and various other complicated details of construction and design. Every electrician must reduce this quantity to the standard of his own instrument. It will be subsequently seen, that it is easy to reduce to one universal standard the insulation and condition of every wire and cable in existence, or under construction.

The basis of all resistance tests is the fundamental law of Ohm, which is expressed by the formula:—

$$R = \frac{L\,C}{S},$$

where R = the resistance;
L = the length of the wire;
C = the specific resistance of the material employed;
S = its sectional area.

The specific resistance of different metallic bodies (C), varies considerably, as will be seen from the following relative conducting powers of different metals, according to Becquerel:—

Copper	100	Platinum	16·4
Gold	93·6	Iron	15·5
Silver	78·6	Mercury	3·45
Zinc	28·5		

The relative conducting powers of iron and copper, which are the materials usually employed for telegraphic purposes, are, consequently, as 15·5 to 100, or as 1 to 6·45 nearly.

The resistance of a wire is directly as its length (L), and inversely as its sectional area (S). If A B represents a copper wire 1 mile in length, and C D one 10 miles in length, both being of the same dimensions and material, the resistance of C D will be exactly ten times that of A B; but if the sectional area of A B is reduced to one-tenth, then the resistance of A B will be exactly equal that of C D. Again, if the wire A B is made of iron instead of copper, the same dimensions being retained, the resistance of A B will be six and a half times greater than that of C D. If now, A B is reduced to six and a half times its length, its resistance will again equal that of C D. Thus a short length of fine iron wire, will offer the same resistance to the passage of an electric current as a long length of ordinary-sized copper wire, and will produce the same phenomena. One mile of No. 40 iron wire offers the same resistance as about five hundred miles of No. 16 copper wire. Short lengths of this iron wire are cut to represent any separate lengths of copper wire of the usual dimensions, and are wound round bobbins, forming a series of what are called "resistance coils." They can be made to represent any length of cable, but the series usually constructed consists of two hundred and twenty-one miles of No. 16 copper wire. By these means, the resistance of any cable can be ascertained, it being only necessary to compare the resistance of the material of which it is made with that of No. 16 copper wire. Thus the resistance of the Channel Islands cable is to that of No. 16 copper wire as 36 to 17; consequently, 17 miles on the author's resistance coils are equal to 36 miles of the Channel Islands cable. In the case of the Gibraltar cable 1 mile on these coils would represent 8 miles of that cable.

* * * * * * * * *

The laws of induction are much more intricate than those of resistance. Electricity develops itself in two forms, dynamic and static. A dynamic current is a very different phenomenon from a static charge. A flash of lightning cannot be compared to the gentle current, generated by the tongue, between a shilling and a penny-piece; but they are one and the same thing under different forms. A thunder cloud can be dissipated as a dynamic current, and a dynamic current can be developed into a thunder cloud. Conduction performs the first, induction the last operation.

The insulated conductor of a submarine cable is a Leyden jar, of which the wire is the inside, and the outer iron wire, the earth, or the sea, the outside coating. Before this Leyden jar can conduct a current, its whole surface must be charged statically by induction. When a current is thrown into a wire, its first influence is absorbed, as it were, in raising the surface of the conductor to a certain static tension, where it remains latent as long as a current flows through the conductor. But immediately the current ceases, and the end of the wire is placed to the earth, the static charge flows out of the conductor at both ends, as a dynamic current. It matters not whether the end be to earth, or be disconnected, the phenomenon is the same in effect, though different in degree. If only one end is placed to earth, the other being disconnected, the whole charge flows out at that end. If both ends are to earth, the discharge is divided between the two. It is for this reason that in passing a current through a long submarine cable, it takes an appreciable period before it appears at the distant end, and when the current is stopped, it continues to flow out at that end for some time after contact has been broken, while at the same time another current of the same duration flows out at the near end; hence the speed of signalling through long cables is reduced.

The first rush of electricity into an open wire is called the "charge." Its return, when the end is disconnected, is termed the "discharge." The current flowing out at the near end, when the distant end is to earth, is the "return current." The delay of the appearance of the current at the distant end is its "retardation." The drawing out or lengthening of the current, as it appears at the distant end, is its "prolongation." These different properties have each their own independent laws, and have recently received full examination and development; but as the testing, and not the working of submarine cables is now under consideration, the author will abandon the inquiry into those laws affecting retardation and prolongation, and apply himself strictly to the charge, the discharge, and the return current.

The charge and discharge obey the same laws; the one is only a reflection of the other. Whatever, therefore, is said respecting the charge, is strictly applicable to the discharge. The return current is simply a modification of the discharge.

Now the charge of a wire depends:—

1st.—Upon the distance between the inside and the outside coatings, the ratio of which is expressed by—d[1].
2nd.—Upon the specific inductive capacity of the insulating medium —s.
3rd.—Upon the surface of wire exposed to induction—S.
4th.—Upon the length or resistance of the conductor—R.
5th.—Upon the power of the battery—n.

The law which regulates it may be expressed by the formula:—

$$C = \frac{n\,S\,R\,s}{d}.$$

But as all induction tests in submarine cables are simply comparative effects between certain phenomena, upon known and unknown lengths of the same wire, the consideration of the thickness and inductive capacity of the insulating medium may be discarded, and attention be alone directed to the surface exposed, the length of wire under examination, and the power of the battery used. The formula therefore becomes:—

$$C = n\,S\,R = n\,l,$$

when S and R remain equal, l being the length of wire.

Thus if it is desired to compare the charges of two separate wires:—

$$C : C' :: n\,l : n'\,l'$$

or, when the same power is used in each case:—

$$C : C' :: l : l'$$

and, if the lengths of the cable are the same:—

$$C : C' :: n : n'.$$

From these proportions it follows that if a wire 10 miles long, gives a discharge of 10° with one hundred cells, it will give 20° with two hundred cells, or 50° with fifty cells; and if the power remains the same, it will give 5° with 5 miles, and 20° with 20 miles. Hence, if the discharge of any unit length of wire is known, the length of wire under manipulation can easily be calculated by the above proportion. An example may be interesting, and more explicit. The cable between Guernsey and Jersey was recently broken, the ends being completely disconnected, and it was tested from Guernsey. Between Guernsey and Alderney, 23½ miles, thirty-six cells gave 28°; from Guernsey to the fault, the same power gave 20°:—

$$\therefore 28 : 20 :: 23\tfrac{1}{2} : 16\tfrac{11}{14}.$$

The actual fault was 17¼ miles off, being an error of scarcely half a mile in the test.

The return current differs from the discharge in name only. The term "discharge" is simply applied to the return current, when the distant end of the wire is disconnected. The term "return current" is applied to the discharge when the end is to earth, or when resistance is interposed between the end and the earth. The discharge formula becomes:—

$$C = \frac{n\,l\,r}{a},$$

a being a co-efficient depending upon the length of wire, and the time that elapses between the breaking and making contact, whence it follows

[1] This ratio (d) is expressed by Professor Thomson* thus: $2 \log. \frac{D'}{D}$; where D is the diameter of the wire; D′ the diameter of the insulating medium; and log. the Napierian logarithm. Professor Wheatstone's ratio† is $\sqrt{\frac{r}{t}}$; where r is the radius of the wire; and t the thickness of the coating.

* *Vide* "Report of the Joint Committee appointed to Inquire into the Construction of Submarine Telegraph Cables." Folio. London, 1861. Minutes of Evidence, p. 126.
† *Ibid*, p. 281, *et seq.*

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that as the resistance of the end r is increased, the return current is also increased, until r is infinite, when the return current equals the discharge. The converse of this would occur when the resistance lies between the submerged wire and the testing place; but as in practice it is always possible, and indeed essential, before commencing the operations, to make the tests at one end of the cable, this question need scarcely be examined. —W. H. Preece *On Submarine Cables.*

AN ELECTRIC TELEGRAPH IN THE YEAR 1815.

The following is a *verbatim* extract from an "Address to the Public," dated 1815; by the late Mr. Ralph Wedgwood, the inventor of the Manifold Writer:—

"The Fulguri-Polygraph, which admits of writing in several distant places at one and the same time, and by the agency of two persons only.

This invention is founded on the capacity of electricity to produce motion in the act of acquiring an equilibrium; which motion, by the aid of machinery, is made to distribute matter at the extremities of any given course. And the matter so distributed being variously modified in correspondence with the letters of the alphabet, and communicable in rapid succession at the will of the operator, it is obvious that writing at immense distances hereby becomes practicable, and further, as lines of communication can be supplied from any given point, and those lines affected by one and the same application of the electric matter, it is evident from hence also that fac-similes of a dispatch, written as for instance in London, may with facility be written also in Plymouth, Dover, Hull, Leith, Liverpool, and Bristol. or any other place, by the same person, and by one and the same act. Whilst this invention proposes to remove the usual impediments and imperfections of telegraphs, it gives the rapidity of lightning to correspondence, when and wherever we wish, and renders null the principal disadvantages of distance to correspondents. Independent of the advantages which this invention offers to Government, it is also susceptible of much utility to the public at large; inasmuch as the offices which might be constructed for the purposes of this invention might be let to individuals by the hour, for private uses, by which means the machinery might be at all times fully occupied, and the private uses which could thus be made of this invention might be applied towards refunding the expenses of the institution, and also for increasing the revenue. Innumerable are the instances wherein such an invention may be beneficially applied in this country, more especially at a time when her distinguished situation in the political, commercial, and moral world, has made her the central point of nations, and the great bond of their union. To the seat of her government, therefore, it must be highly desirable to effect the most speedy and certain communication from every quarter of the world, whilst it would at any moment there concentrate instantaneous intelligence of the situation of each and every principal part of the nation, as well as of each and every branch of its various departments."

In the *Commercial Magazine* for December, 1846, from which the above is taken, the following remarks relative to the invention are made by Mr. W. R. Wedgwood, the son of Mr. Ralph Wedgwood:—

"After the perusal of the above extract, it may be asked, why did not Mr. Ralph Wedgwood carry his invention into practical application? This answer is very obvious. Railways were not then in existence, and the connecting medium required an uninterrupted course such as railways alone afford. Such an invention also required the assistance either of Government or a powerful company, the scheme being too gigantic for an individual to work. The inventor, then, it will be perceived, did all that was possible in his power to bring the discovery into practical use; for, in the first instance, he offered it to the Government, who refused it; and it was for the benefit of the nation, he then made public his scheme of an electric telegraph in the manner quoted from his pamphlet.

"From the consideration of the above facts, which can bear the strictest investigation, it must be apparent that Mr. Ralph Wedgwood is entitled to the consideration and esteem of society for his inventions, as this is not the only discovery that a life of unwearied practical investigation bequeathed to his country.

"Should you, sir, be induced to insert the above fact in your extensively circulated journal, you will confer an act of justice on Mr. R. Wedgwood, and a great favour on his son.—Your obedient servant,

"W. R. Wedgwood.

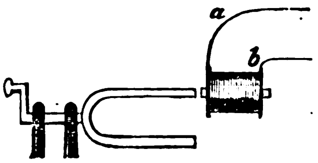
"3, *Cryssel Road, North Brixton, Nov.* 19*th*, 1846."

The Student.

MAGNETO-ELECTRICITY.

We have seen that a current of electricity, traversing a helix or coil of wire surrounding a bar of iron, induces magnetism in the latter, and gives to it all the properties of a natural loadstone or a magnetized bar of steel. It was discovered by Faraday, that the converse effect is produced by reversing these conditions, *i. e.*, that by introducing a magnet into the axis of the coil, a current of electricity traverses the wire in the same direction as that which would be required to *produce* a magnet with its poles similarly disposed in regard to the helix. This current, however, is but momentary in its duration. Upon withdrawing the magnet, a current occurs in the opposite direction. It follows from the above, that if the magnet be now reversed, and again introduced within the coil, a current will be induced in the same direction as the last-mentioned, and that upon the withdrawal of the magnet the deflection of the galvanometer will be the same as produced by the introduction of the magnet in the first instance. It is important that these facts should be remembered; for upon their application depends the construction of various forms of the magneto-electrical machine, in which the reverse currents are so distributed as to give a dynamic effect in one determinate direction.

Upon bringing one of the poles of a permanent magnet into contact with the extremity of a bar of soft iron, the latter becomes a magnet for the time being; the position of its poles being contrary to that of the poles of the permanent magnet. In other words, the extremity of the iron bar becomes by magnetic induction a south pole when in contact with, or in proximity to, the north pole of the magnet. Upon placing, therefore, a bar of soft iron within a coil of wire, and bringing the pole of a horse-shoe magnet in contact with one of the extremities of this soft-iron *core*, a momentary current of electricity will traverse the wire of the coil, which will be rendered evident if the extremities of the latter be attached to a galvanometer. On removing the magnet, a current will occur in the opposite direction; and contrary currents will be produced when contact is made with the opposite pole of the magnet. The ordinary magneto-electric machines are constructed upon this principle. But instead of rotating a magnet so as to bring its poles successively into contact with one of the extremities of the core, as would be effected by the arrangement in the following sketch, increased effect is produced by placing the core in a direction at right angles to the axis of the magnet, so that the poles of the latter may simultaneously be in contact with the two extremities of



the core. The core thus becomes the armature of the magnet, producing what is termed a closed magnetic circuit twice during each rotation. It is usual, however, to construct the soft iron core of two cylindrical pieces, united by a flat piece of iron, the wire being coiled upon two bobbins, as in the improved form of the electro-magnet now generally employed. Again, instead of rotating the permanent magnet, the soft iron core, with its coils of wire, is generally made to revolve, by which means the loss of magnetism by the continued vibration is reduced.

When quantity effects are to be produced, the coils surrounding the core are wound with a comparatively short length of stout wire; while, if currents of intensity are required, as in the magneto-electric machine, for medical use, a considerable length of fine wire is employed.

We shall next week refer to the general principle on which the commutator, or *current changer*, attached to the machine when used for electro-plating and other purposes for which a succession of currents in the same direction is required, is constructed, and also to some comparatively new application of the principles upon which the magneto-electric machine is based.

International Exhibition.

MAGNETO-ELECTRIC MACHINE, EXHIBITED BY M. AUGUSTE BERLIOZ.

It is something to find that magneto-electric machines for the production of the electric light have hitherto been constructed upon a

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wrong principle; and that this is actually the case would appear from an inspection of the machine contrived for this purpose by M. J. Van Walderen, and adopted by the Alliance Company of Paris. The distinguishing feature in this machine, shown in the French division of the Western Annexe, is simply the absence of the commutator for giving a constant direction to the current. By a not unnatural, but somewhat illogical conclusion, it has been assumed that the action of the commutator—giving what the French call *des courants redressés*, is as necessary for the electric light as it is for the electro-deposition of metals. Here, however, we have a brilliant and uninterrupted light produced by a succession of currents alternately in opposite directions, and this with a smaller number of magnets, and a less expenditure of motive power than are usually found necessary. Watching the action of the commutator in the powerful machine of Mr. Holmes, exhibited in the English department of the Western Annexe, we can scarcely fail to arrive at the conclusion, that a great loss of electric power is taking place. The vivid blue lightning that plays about the wheels plainly indicates that a great amount of resistance to the passage of the electricity which is generated, is opposed by the contrivance for continuing the current in the same direction. By this contrivance also, either the currents must be continually interrupted, as would be the case without the commutator, or, what appears to be more objectionable, a double contact must constantly be taking place with the neutralization of opposite electrical tensions. Moreover, the roughened surface of the wheels of the commutator, which may be ascertained by passing the hand over their peripheries, shows that the contact is liable to become more and more defective. In the French machine there are no frictional contacts, and, consequently, no wear or disintegration, and no danger of defective arrangements for distributing the electrical force. The terminals of the helices surrounding the iron cores are simply collected to form the two poles; those wires being together in which the currents occur simultaneously in the same direction; and when connected with the electric lamp with charcoal points, the light is produced by the revolution of the permanent magnets.

THE PHYSICAL GEOGRAPHY AND HYDROGRAPHY OF THE ARCTIC REGIONS.

THE evidence of Capt. Sir Edward Belcher, C.B., given before the Submarine Telegraph Committee, has been often referred to in this journal, in connection with the North Atlantic Telegraph route; and is of sufficient importance in regard to the conditions for establishing telegraphic communication with America through the Arctic regions, to induce us to quote it, *in extenso*, for the benefit of those of our readers who may be interested in this problem.

(*Chairman.*) You have had considerable experience, I believe, in polar navigation, both north and south?—On both sides of America, in Behring's Straits as well as the other side. More particularly in Behring's Straits and the banks of Newfoundland among the icebergs.

Have you formed any opinion as to the practicability of laying a cable to America by way of the Faro Islands, Iceland, Greenland, and Labrador?—I have.

Assuming that we start from England, you would go to the Faro Islands, I presume?—I should prefer going to the Shetlands first.

From the north coast of Scotland?—From the north coast of Scotland, via the Orkney Islands.

And from the Shetlands to the Faro Islands?—Yes.

Have you considered or observed the tides and whirlpools which are said to exist near the Faro Islands?—I have not; nor have I witnessed any of those whirlpools on the direct passage to Greenland. I think they belong peculiarly to the islands and to the tides which belong to the islands. I consider that the tides in the vicinity of the land always differ materially from the tides off shore.

Do you anticipate that there would be any liability to injury to a cable from friction on the rocks in consequence of those tides?—I do not. I consider the information that we have at present of those islands is very imperfect, and that it is almost absurd in any person until he does obtain the information that is requisite, as to were the banks lie, and whether those banks are mud or sand or rock, to assert that the thing cannot be done. I have had a great deal of experience all over the world in dealing with rocks near the land, but I never knew of any rock bottom in 100 fathoms off shore except in the Coral Islands in the Pacific. There, I think, at 960 fathoms we lost the rock, and the bottom was found to be sand. After it has been *determined*, how the rocks lie, and if there are available gullies between them, containing mud or sand, then it will be easy to place in such situations cables adapted to the cases. In all such cases (as it has been imagined apply to islands like Shetland and the Faro Islands), I would venture to suggest that you have been dealing with others much more liable to objection in the Mediterranean, and specially as to terrestrial heat! I view the islands above water as merely apices of what would be disclosed if the sea receded; and if abrupt ravines discover themselves at the coast line, they may naturally be looked for as continuous below water. But being filled with mud and debris, they offer a good bed for a cable, judiciously laid in any of these determined hollows. Therefore, I must be understood in my replies to mean, that I would not run the cable *direct* and *across ridges*, but carry it to *the communicating branch*, which I suppose would run in the meridian north and south from the positions in question.

Is the mud as a rule deep at 100 fathoms?—I think whenever you come to mud at that depth it is very slimy mud. In all cases where I have seen rope or any material that has been sent down in very deep water the mud has adhered to it when it came to the surface with great tenacity, and it was very difficult to wash it off. A very peculiar sticky mud is found at great depths. I think if you were to determine the outline of the soundings at 100 fathoms, and bring the cable up into the meridian of any of those points to which you propose to carry the line, you could run it up on that meridian perfectly free from any chance of troubles from icebergs. The ice in all those regions from Europe until you go round Cape Farewell and get on the west side of Greenland is merely floe ice. Floe ice, in ordinary times, should never exceed 7 feet in thickness. The law is half an inch, or 0·44 increase, for every day during the winter months. So that you may arrive pretty nearly to what the floe ice should be. When you find what are termed heavy floes of 21, 22, 23, or 24 feet, that results from the breaking up of the floe, and one portion pressing above another until seven or eight layers become attached to each other. and the first thaw cements them into one mass.

The floe ice, I believe, rises very little above the surface of the sea?—One-twelfth. I find that the immersion is $\frac{11}{12}$ths. I am taking the specific gravity that has been given us by different authorities, that would exactly make it, as nearly as possible. I see in the former voyages by Phipps, that the floe ice got as high as $\frac{21}{22}$nds of immersion, some of the densest ice that they fell in with, the water being previously purged of air.

Have you visited the coast of Iceland?—I have not.

Along the east coast of Greenland you think there is no danger from anything but floe ice?—I think not, from the account of Lieutenant Graah, the Danish navigator, he having passed along the eastern coast close in shore in an oomiak, where he found the bergs calving off to sea. The water is so deep that there is no chance of bergs troubling the ground, and consequently any cable, if it were carried up in a ravine in the fiords on that side, would be quite safe, because the berg would strike the ground on either side of the deep gulley without troubling the cable in deep water.

The bergs come from some point further to the north, do they not?—The bergs come from both sides of Greenland; they break off from the shore. They result from a thaw turning the water over the ice that happens to be formed over the face of the land, until at last the weight becomes so great, added to the sea underneath acting as a wedge, that down it comes. In fact, the concussion of a gun being fired would bring it down. The icebergs are fresh-water ice generally, and the ice that is formed nearest the land should be of much greater density than that which is on the surface, because there is a pressure of some thousands of tons upon it; and we know that ice is compressible, because in the case of beer bottled in champagne bottles, it throws the beer out of the bottle itself—the ice compresses itself, and instead of bursting the bottle, as it does with a shoulder bottle, it only forces the cork out and closes the bottle. I had a very thick glass cylinder belonging to a magnetic apparatus, and I stopped one end, and filled with water at 60 degrees. I then froze it under a temperature of 52 degrees below zero, and I fouud it only elongated half an inch, so that there were $\frac{23}{24}$ths, one may say.

Have you had any experience in the interior of Greenland?—No, I have not. I have been up the fiords for some short distance. I went in between Disco and the main. I passed through that channel for some distance.

Have you formed any opinion as to what point of the east coast of Greenland you would carry the cable to?—I should propose carrying it as far south as I could into the first fiord that opens.

And then you would carry it overland?—Yes, I would carry it overland, because the land about there, according to the description of several hunters who have been there, is low, and there are numbers of

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reindeer about; they will not live on the high land: they would have to go to the grass, and they burrow like sheep or like bears, and seek their food on the ground. They are reported to remain under the snow all the winter, and the hunters know where to find them by the air-holes.

Is the climate such that you could maintain a line all the winter do you think?—The great point would be, that you would have to employ a pretty large force on shore to cut down to the earth, and as soon as they got sufficiently low to get beneath the ordinary frost of each successive winter, I consider that the cable would be perfectly safe.

You would lay a subterranean line?—At least so low in the earth as I could get, so as to prevent a thaw bringing it actually into contact with the surface during summer. There are no moving glaciers mentioned on the southern point; the glaciers to be avoided are about two degrees northerly from the Cape. My meaning here applies to a subject not properly explained. The earth is generally frozen to the depth of six feet and more. If a proper trench be opened in spring, and the water resulting from thaws flowed in it during summer, it would cut a good channel. Any cable placed there, and properly covered with the detritus, would be perfectly secure, and *no surface action could reach it.* It would remain for ever unharmed; but this should be of peculiar construction, and proper structures, or cavities, cut into the rock, prepared for its security, as well as for easy access at the termini.

Do they go out to the east and west?—Yes, as far as I can understand from Graah's work.

In passing through Greenland, you would not anticipate much difficulty?—I think not; but that is only a mere matter of opinion. I have read the account of Graah very attentively, and I see that he had no difficulty in crossing over the land there; and therefore I consider that people with better means and a good supply of food would find no difficulty.

From Greenland, would you go to Julianshaab?—To one of those southern fiords.

And then across to Labrador?—Yes. There is a point that seems to have been overlooked hitherto; it is reported that a bank runs between Labrador and the coast of Greenland; there is a ridge somewhere, which is well known to whalers to exist; a spur from Labrador, which reaches across towards Greenland, and turns the ice from the Labrador coast off towards Cape Farewell. The currents out of Hudson's Strait, Davis's strait, and Cumberland Sound, must tend to drive the ice out to the eastward; it meets with the eddy of the gulf stream, which deflects it to America and the Banks of Newfoundland about St. John's; but the space about the mouth of the Straits of Belle Isle, and around there, is generally free from ice all the year round. I have been since informed that this bank extends north and south off the coast of Labrador, and the cross bank has never been satisfactorily proved. If this be the case, the tail of this meridianal reef, where it affords 200 fathoms mud, would prove the best point from which to start the connection to Greenland, assuming the spaces within to be protected by the bergs which are said to ground there. I think, after mature consideration, that all the lines should be run *independently from* the *western to* the eastern stations.

Along the coast of Labrador?—I do not know how far up, but I should think it would be almost up to the mouth of Hudson's Straits. I do not think there would be any ice from that region which would press on the coast of Labrador, in proof of which none of the whale ships that have been beset or destroyed by the ice have been deposited upon that shore; therefore I suspect that the whole of that coast is kept free by the many inlets and currents on the shore. The currents set up upon the western side of Davis Strait and down southerly upon the other, and you are obliged to work up on the east side till you reach Cape York, and then cross over and come down the west side; consequently the current which is running down the western side tends to sweep out south-easterly across towards Cape Farewell. The water about the north-east angle of Labrador is so very deep that there is no chance of any iceberg grounding there.

And the ridge of which you have spoken would prevent icebergs coming out?—It would tend to intercept the current and divert it easterly.

It would intercept any icebergs which were sunk below in a great depth of water?—If they arrive at this ridge which is supposed to run across, undoubtedly they would ground upon it, and be driven off in the direction of the current.

If the cables were laid south of this ridge, in your opinion, it would be protected from icebergs?—Yes; my idea of laying a cable is to seek a depth at which no icebergs would touch it, and just to keep on the deeper verge of that depth, working along it until you come to Newfoundland itself. It should be attached to some vessel moored off until you have secured your communication, and then run across to Greenland. The heavy ice never presses upon Cape Farewell, and never has been known to touch the southern part of that land at all. My view in taking this route is not distinctly connecting it with any particular position in Labrador, but with Newfoundland at the Strait of Belle Isle, *if found convenient.*

The ice is always carried round it?—Yes.

And does not touch the east side of it?—No, I believe not. With regard to Newfoundland, I have counted in the month of May as many as 80 icebergs at a time on the banks of Newfoundland; and during the period I was employed there, the only berg I saw grounded off the shores of Newfoundland was in 16 fathoms. The ice is so very nicely poised that if it was passing along the bottom I do not think that there is much chance of its raking the bottom; it would quietly roll over as a roller would do, and impress the cable into the ground, instead of damaging it; it would not rut the ground up. The moment it touches the bottom you can observe it turn over directly, as easily as possible from the very nature of its construction. The temperature of the sea beneath is always about 36° to 38°, consequently it must be thawing; and as the under part of the ice is always in a thawing state there would be no edges to cut.

Except at the moment of its turning round?—No; it would turn over, only requiring very little assistance to change its natural position of rest. I allude specially to bergs rounded, not field ice. The difference between berg and floe ice is very remarkable, and I think some people have drawn their conclusions from the aspect presented by upturned floe. The berg dissolves smoothly, and when it revolves presents a glossy smooth globular-shaped surface. But the case is totally different with floe ice. There the warm air globules rising from below bore into and honeycomb the under surface; indeed these air holes sometimes nearly pass through the floe, making *smooth holes like an augur* or pholas, varying from 1 to 1½ inches in diameter. Masses of such ice upturned are found to be very difficult to walk over, and offer a troublesome obstacle to sledge travellers. I think the rutting traces of grounded ice *forced up* by *external pressure* has tended to form the opinion that bergs tear up the ground they pass over.

Your opinion is that it would be very feasible to lay and maintain a cable along the coast between England and America by the route of Iceland, Labrador, and Greenland?—Yes; I can tell you a little more about the bottom of the sea on the west side of Greenland, because I dredged along this coast, working up to Disco from the southward, and I found it all mud even in about 15 or 16 fathoms. There is a bank off Holsteinberg, which is composed of fine sand, where they catch great quantities of cod.

Your idea would be, I assume, to carry it from there towards the Straits of Belle Isle?—I would carry it for instance to the Shetlands. I believe the whole of these parts have been sounded by Captain Thomas; and I think the Faro Islands also. As soon as you have determined, by sounding, that there is no rock, the better way would be to run in that direction. On Iceland we have no knowledge at all of any soundings. There is a fishing bank off there where the French are said to fish.

Off the south point of Iceland is not there a certain amount of volcanic bank, on which, as late as 1830, a volcano was seen, or smoke was seen issuing from the sea?—I do not know, but we had Graham's Island thrown up off the coast of Sicily, but it has gone down, and there is a *sand bank* instead of it. I think the same objection, if it be made, applies equally to all portions of the oceans depths, and more particularly to the Mediterranean. But how it is to be discovered, beyond absolute test perpendicularly above the spot, I am at a loss to comprehend.

Would not that be rather an unsafe place to lay a cable, in case the island might come up again?—I do not know that; it would depend upon the temperature of the water around. If the temperature of the water around there is high, why the further off (in deep water) the cable is the better.

From the south coast of Iceland to near Cape Farewell?—I would run it as nearly as possible in the parallel until it arrives near the land. I would then take it into some of the fiords across there. From Graah's account, there is no ice here during the early summer months. There is the floe ice, which is attached to the land, but it cannot be of any importance, because whenever a heavy breese sets in, the effect of the sea working under the floe, detaches it and breaks it up. From none of those fiords being clearly laid down, there can be no route determined through the floe. About August it is free from ice.

Still, the northern part of the east coast of Greenland is entirely locked up with ice, is not it?—It has not been satisfactorily examined. Here is Graah's Island, where he stopped; but then he had nothing

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but a skin boat, a thing that in the seaway twists and turns in every manner. You can hardly make use of it at all. I know that the oomiak is a very difficult thing to handle in a seaway. In some of the northern portions of Greenland, Scoresby says thet he saw grass land. In the month of June he had grass and very hot weather. On the other side of America, at Behring's Straits you have ice, and at Blossom shoals I observed ice aground in 20 fathoms; but that is the deepest water in which I ever saw ice aground on that side; that is in 120 feet water. I do not think that the experience of Graah in an open oomiak, a mere skin boat, can be assumed as a guide as to the ice to be dealt with on the east coast of Greenland. I am, however, inclined to think that it will be imperative to watch carefully for the period to start from Greenland, and connect with the vessel lying off. Also that the question of connecting it again with Iceland should be secured by some beacon off shore, if it should happen that heavy westerly gales prevented running into port. These are matters demanding the most scrupulous investigation, and of infinite interest to navigation should our ships be stationed in that neighbourhood.

A question has been raised about carrying the telegraph round by Asia to America. Would there be any difficulty in carrying it by the Aleutian Islands from one continent to the other?—I should say yes, by the Aleutian Islands. It could be carried from Cape Prince of Wales to East Cape. It is only 30 miles across.

The Aleutian Islands would not form a stepping stone?—No, I think not. I think you would find great difficulty. They were originally volcanic. Upon the Alaska Peninsular we saw two volcanoes in action. The preceding remarks apply with greater force here. The Aleutian Islands are volcanic, and offer ironbound coasts.

Are many of these parts inhabited?—They are all inhabited.

You think it would be better to go further north?—I think it would be better to go to Cape Prince of Wales. From Norton's Sound to Cape Prince of Wales there are no mountains of any importance that would interfere with it, and you might make a communication by the river all the way to Norton's Sound, and carry it through the lakes up to the Mackenzie. From the Mackenzie the river would run by Porcupine River all the way to the head of Norton Bay, and from Norton Bay across to Cape Prince of Wales. There is a very good harbour at Port Clarence, where the "Plover" wintered.

Is not the Russian Government at the present time constructing a telegraph as far as the Amoor?—I do not know, but if they run it to the Amoor they can very easily run it on to Kamtschatka.

Professor Wheatstone.) Is the country north of Kamtschatka inhabited?—It is inhabited all the way throughout the whole of the north coast of Siberia.

(*Chairman.*) Are there no currents between Labrador and Greenland which would be injurious to laying a cable?—There are no ocean currents, I think, that would trouble any cable in any part of that region that I know of.

The current at the bottom of the sea is not very strong, I suppose, in any case?—It decreases till you get to the bottom. In several cases it runs with the same force down to 1,000 fathoms. Off Cape de Verd I tried by five different depth of line, 100, 200, 400, 600, and 1,000 fathoms. I but them all over together from different boats, and watched them for two hours. The ship was drifted at the rate of five miles an hour past Cape de Verd. The whole of the barécas, which occupied the space of this room, never separated. In 1,200 fathoms off the Gallapagos, on the Equator, in the Pacific, I had the line up and down for at least half an hour. The vessel drifted very rapidly past the island, but there was no deviation from the perpendicular,

As if the whole section was moving together?—Yes.

It would not be like the case of a river, where the sands are confined by banks; there is no friction comparatively in the sea?—No.

Have you sounded in very great depths?—4,600 fathoms.

What process of sounding did you adopt?—I had about 40,000 yards of solid whipcord made for the purpose at Preston, capable of supporting a hundredweight, and I used weights of 28 pounds.

Did you recover your weight, or leave it at the bottom?—I lost the line. It was not worth while to recover it.

You pull it taut until the line breaks?—Yes.

And that gives you the depth?—Yes, when it ceases to take the slack.

Do you think there is any uncertainty in these deep sea soundings?—Very great. There may be two or three different under currents which you know nothing at all about. Even with 4,000 fathoms you may draw the line with your finger, but you cannot tell that it really is at the bottom. The last 100 fathoms goes out about a yard a minute. There may be an under current sweeping it away, and you think it is descending. But the mode that I adopted to obtain these soundings enabled me to determine that the sounding up to 2,000 fathoms was in a vertical line. The line was on a metal reel, and it passed over another three feet reel, with a trochiameter in its centre, so that I could take the velocity of the line until it stopped. Of course I knew it was descending, but the moment it began to travel, only at the rate of about three feet in a minute, I began to pull up again. In some cases I had to pull up about 20 or 30 fathoms without breaking; but all the lines that go that depth into the water become unlaid and useless, and therefore it is not worth while recovering them.

What does that arise from? From the pressure, I suppose.

In paying out?—No; the line kinks and doubles back upon itself, and becomes very long jawed, so much so that very well-laid whipcord (I suppose I recovered about 300 or 400 fathoms), was utterly useless, all unlaid, entirely twisted out. That of course rendered the hauling-in quite out of the question as to descent. This untwisting *is far below the surface.*

Is that from getting a sort of revolution in passing through the water, the friction of the water causing it to revolve and untwist?—No, I do not think it is. Almost all new fishing lines that are used in deep water are the same; even a new line of 60 or 70 fathoms used for cod fishing you have to dry and twist again; you have a great deal of difficulty in taking care of the line.

Do you bring up the bottom from great depths?—Yes.

Is that done by a second operation?—I did it when I sounded, of course bringing the instrument up again, and that brought the water up and the temperature from that depth. It was a separate machine. I used a tapered line for that purpose beginning at about half an inch, and the upper end of the line was 3½ inches. We were obliged to have such a line, otherwise the strain of hauling it in would break the lower line; but with a wire, that would not be necessary, because the power of the wire would be quite equal to a rope of that size. The Americans detach a ball which slips off, and they recover their line. Sir James Ross spoke about the Spitzbergen currents. Those currents do not seem to run at a greater velocity than about four miles a day, which is nothing. I have some extracts from Parry's voyage, from which it appears that at 400 fathoms, which was the greatest depth in 82° 17½', and a daily drift of 3 375 in 82° 45' he had no bottom at 500 fathoms, and he estimates his drift at four miles a day, that drift preventing him from nearing the North Pole, which he was then endeavouring to reach. Lieutenant Foster reports that "during their absence after the middle of July no ice had entered the northern bay of Spitsbergen, and that not a piece had been seen in the offing for some weeks past, even after hard northerly and westerly gales."* Therefore I do not think there is much to be feared from the Spitzbergen ice; that evidently does not come down to the southward.

You think there is very little to be feared from ice between England and Greenland?—During the whole passage from the Orkneys to Cape Farewell I did not meet with a single berg until we got within 300 miles of Cape Farewell, and that was only a little bit of ice, it was no berg.

Between Greenland and Labrador the bank which you mentioned would protect the cable from bergs?—The bank that runs round Cape Farewell and runs up that coast would protect the cable completely, because the evidence given by the Danes on that coast is, that no icebergs ever ground on the west coast of Greenland. It is off shore that they can see it pass, but then it is probably in 1,500 or 2,000 fathoms.

What was the greatest depth of sounding that you took between Labrador and Greenland?—I never obtained any deeper sounding than 60 fathoms.

That was further to the north I suppose?—It was along the coast southerly and abreast of Holsteinberg.

Have you been by Hamilton's Inlet at all?—No; I do not know anything of it. The greatest measured height of any iceberg that I ever saw was 150 feet as a pinnacle, and when it canted, or turned bottom upwards, it was not above 80 feet.

Sir James Ross suggested going to Rockall instead of Iceland, and from there to Cape Farewell, in order to avoid the danger of volcanic action at the south coast of Iceland, and the currents at the Faro Islands; I understand you to say that the currents do not extend beyond the mere shores at the Faro Islands?—These are points that we want determined; it is a mere matter of opinion; assertions are

* It has generally been remarked, that where even slight current prevails, "Ice will go to windward in the teeth of a "heavy gale," and looking to the power exerted on isolated masses, with 11 parts pressed on by current against 1-12 to the breeze, it is easily accounted for.

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made simply that those currents exist; but it does not follow, because you have those constant eddies and apparent whirlpools, that there should be a current, because I have tried the currents in similar whirlpools, and have found none.

There was no current moving bodily, you mean?—No. In the Mediterranean, over the Skerki rocks, between Africa and Maritimo, there are tremendous currents or eddies, that you really fancy you must be in some danger of a whirlpool, or something of the sort. I have sounded and found not the slightest current. The whole of the space between Tunis and Maritimo was closely surveyed by myself from shore to shore, and I could generally get bottom. I knew precisely when I got the lead to the bottom what was going on at the surface. Very frequently in the Bahamas and about there, out of the gulf stream, you have these extraordinary eddies, without any apparent cause at all; and the same at Bermuda, where there is no tide, you have these eddies. I always attributed them to fish below, perhaps whales, or something of that sort.

Are those eddies which arise for a short time and then cease?—Yes; in the track of a whale, it may be a mile or a mile and a half from you, you come suddenly into its track, and you find a sort of whirlpool, and then you will see the whale at a distance, and know positively what the whirlpool, arises from. In the Pacific that is very frequent indeed. I want to know if Sir James Ross maintains that the current exists through those islands, why it ceases immediately after leaving the islands, and why we are not driven out of our course. Between England and Cape Farewell we steer a course calculating upon some slight currents, because we know very well the general tendency of the stream, and that the head of the gulf stream sets in a precise direction. We never find ourselves very much out of our reckoning, and, therefore, I am not disposed to accede to the existence of that current until it is proved.

Assuming a line of cable to be laid down, do you imagine that it could be all laid in several sections at the same time of the year, or would you select a different period of the year for laying each section?—I think it could be all laid at the same period of the year, but I think each portion should be laid separately.

I mean whether the season of the year which was favourable for laying one section would be the season of the year that would be favourable for laying another section; for example, whether on the east coast of Greenland the same period of the year would be as favourable a one as it would be for laying it on the west coast of Greenland?—That is the only point that I feel any doubt about namely, the period at which you can get it to or from the east coast of Greenland—that we are none of us aware of; neither Graah nor any other person who has been there has solved that question. Therefore, until that is determined, I should not be disposed to give an opinion, but my conviction is, that between August and October anything that can be done should be done in those months, but you may work upon all the other points from May until October. The ordinary period of receiving our instructions for northern work from the Admiralty is to quit London in March. I see that Parry, in the month of April, was at Spitzbergen; consequently, if he could go up there and *work* in the month of April, I should say from the first of April to the last day of October anything may be done upon that line. The first 10 days of March are always, you may say, 10 of the coldest days of the year up there. After that the summer comes suddenly upon you, and the first of May throughout America is well known to those who have been in Canada and about there; the snow clears off, and you get the May flowers from under the snow. Therefore, that is the first of the summer season. All the different saxifrages and other plants on the southern coast of Greenland are in full flower at that date.

Do you imagine that if stations were established in Greenland and Labrador, the present colonists would be available for the purpose of keeping up those stations during the winter, or that we should have to send out colonists?—I should think on the Labrador coast you would have about as highly-civilized a set of natives as you will find in almost any other part of the world.

And in Greenland?—In Greendland they are very fair.

Of course, they are Danish?—Yes, a mixed race. They have schools, and they are very well clothed, and are perfectly under command; there is not the slightest attempt at opposition. They are thoroughly under the Danish Government, and if the Danish government gave an order, no matter what it was, however impossible apparently to us English, they would have it done; they are very strict with them.

If any expedition were to be sent out, it should start very soon?—Without a moment's delay.

I presume you would select a steamer, such as surveyed the line between Gibraltar and England?—Yes. The sounding part of the business. if the Admiralty pleased so to order it, could leave England is 48 hours. I have not the slightest doubt that there are many surveying officers that are available: for instance, Captain Robinson.

And Commander Dayman?—I should think he would be a very good man to employ in the deep sea part, because the two vessels that go should have quite separate duties. One should be instructed to run in the line of direct sounding upon the edge of the deepest water, and the other vessel should endeavour to work by traverses along the shore, so as to determine how the bank lay; that is to say, to fringe it. I think in doing that, that the officer who is selected should be a practical surveyor, so as to avail himself of all the advantages which such a voyage would confer. The Royal Society might send its mission to be landed upon the different islands, and to be picked up as the ships came back; because there are a great many magnetic observations which would be important to be taken at the same time. Upon the subject of eddies I would remark, that, to my mind, these apparent eddies or whirlpools result from banks of which we do not yet know; and those banks may be very important to this country, as fishing banks near our own coast, instead of travelling over to Newfoundland. I have always found that those eddies arise in the Mediterranean either from gullies or shoals; and, in fact, where you would imagine that they arise from fish, you come immediately to the conclusion that there is a bank upon which the fish live. There is no part of the world where that is so perfectly evident as off the Lagullas bank. Off the Lagullas bank you have those eddies, but you have no great drift; and in three or four different times of crossing I have dredged over a great part of the Lagullas bank, and have taken great quantities of fish; and in the midst of those *eddies* we had no tide whatever. Again, on the coast of Africa, off the Bijuga shoals, there are more of those eddies than in any part of the coast of Africa; but there are no strong currents, although there are regular tides. In fact, where the dredge *can work safely* in 70 fathoms, it is clear that no great current can exist, otherwise it would instantly be destroyed.

Have you considered the plan for laying a telegraph line further to the south, by the Cape de Verde islands, so as to reach America in that way?—Not by the Cape de Verdes. I had an idea about running a cable to that shoal, which exists to the northward of the Azores. That bank has about 35 fathoms of water on it.

Is there no danger to be apprehended from volcanoes?*—I do not know anything about that. There are volcanoes upon the Azores, but on this bank, where there is about 30 fathoms, if it exists, I see no difficulty in mooring a floating vessel without a mast. I have anchored a beacon in 100 and 150 fathoms, on the survey along the coast of Africa, which was carried on at intervals during three years and a half, and I seldom met with any accident, such as breaking adrift. I am perfectly satisfied, if a vessel were moored there, she might be made the medium of working between the two shores.

PRICES CURRENT OF INSULATING MATERIALS.

GUTTA PERCHA.

About 35 tons just arrived from Singapore has been brought forward at public sale, and bought in at very high rates.

Genuine, chiefly woody, decayed, with some better fine	2s. 2d.	per lb.
Genuine, nearly all woody, and much decayed ...	1s. 9d.	„
Reboiled, good	1s. 7d.	„
Inferior, reboiled	9d.	„

INDIA RUBBER.

PARA.—Business has been chiefly confined to purchases by the exporters for America. Very little enquiry otherwise.

Fine Para	1s. 10d. to 1s. 11d.	per lb.
Fine Java	1s. 4d. to 1s. 5d.	„

July 3, 1862.

WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

Colonial and Foreign Telegraphy.

ANGLO-AUSTRALIAN AND CHINA TELEGRAPH.

A DEPUTATION connected with the Anglo-Australian and China Telegraph waited upon Sir Charles Wood, at the India Office, on the 27th ult., concerning the establishment of telegraphic communication between India and China and India and Australia, *viâ* Singapore. The deputation was

* The question of submarine volcanoes will apply to any part of the sea, even to the present line laid. Before the heat resulting reached the surface, it must be abstracted by the water through which it passes.

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introduced by the Hon. A. Kinnaird, M.P., and consisted of the following gentlemen :—

Sir Stuart Donaldson, Messrs. J. Halliday, J. P. Watson, S. W. Hyde, H. C. E. Childers, M.P., J. Ogle, T. W. Evans, M.P., R. B. Wade, Peek, T. M. Weguelin, M.P., F. Gisborne, Fleeming Jenkin and C. H. Ebden.

Statements were made with reference to the subsidies already voted by the Australian, and those expected from the French Government for a line to Saigon.

The proposition laid before Sir Charles Wood was that the Indian Government should give a subsidy towards the section between Singapore and Rangoon, contingent on the successful working of the cable.

Sir Charles Wood informed the deputation that until he was assured by the Treasury that the outlying telegraphic lines from Australia to Singapore on the one side, and from Hong Kong to Singapore on the other, were in a state of actual forwardness, or certain to be completed, he, as representing the Government of India, could not move in relation to the India and Singapore line. But that upon their receiving such assurance from the Imperial Government, he, as Secretary of State for India, would feel it to be his duty, either to carry out as a government work, or to assist, by subsidy or otherwise, a private company to complete the line from Rangoon to Singapore.

Telegraphic News.

PROGRESS OF TELEGRAPHY.

A PLAN for the better detection and prevention of crime in Ireland has been laid, within the last few days, before the Irish executive. It is proposed to connect the police barracks of Ireland by telegraphic wires, thereby enabling the constabulary to encircle any district where a crime is committed the moment information reaches them. Agrarian and other offences are generally perpetrated by strangers hired from a distance, who at present have time to escape back to their own district before they can be intercepted by the police, hence the necessity of a rapid communication between the police barracks. For this purpose mounted constabulary are kept at present at a cost of about £40,000 per annum, whose services, it is assumed, might be dispensed with by the substitution of telegraphic wire, which can be laid at a very small expense compared with that incurred for the horse police.

THE UNITED KINGDOM ELECTRIC TELEGRAPH COMPANY.

THIS company's bill was read, without opposition, a third time in the House of Commons yesterday (June 30). Having passed the Lords in March, the company have now secured the full powers required from Parliament.

RED SEA AND INDIA TELEGRAPH COMPANY BILL.

ON the question that the report of amendments in this Bill be agreed to.

Lord REDESDALE said that, as this measure stood, he believed there would be great legal difficulty in interpreting its terms. It was very desirable that the agreement between the Government and the company should be put into a clearer form.

The Earl of CAMPERDOWN had expected that the precedent of a former measure of this kind would have been followed in this instance, and that the contract between the Treasury and the Telegraph Company would have been inserted in a schedule appended to the Bill. This, however, was not the case, and instead of a contract there was in the Bill what amounted to a very different thing—viz., an arrangement, which, he was informed by legal authorities, would be binding upon the Treasury, but not equally binding upon the company. Upwards of £2,000,000 of public money were involved in this matter, and, surely, such a sum ought not to be granted away without a regular contract being produced between the Government on the one side and the Telegraph Company on the other.

The Duke of ARGYLL had been in great hopes that the arrangements which had been made with respect to this Bill would have satisfied noble lords who had objected to its form on previous occasions. The Government had bound themselves under the agreement of 1858 to pay 4½ per cent. to the old company, while they, on the other hand, after their capital had been spent, were under no obligation to keep the line in working order. Accordingly, after the expenditure of their capital, the company, having failed in working the line, were not inclined to throw good money after bad, and according to the terms of the agreement they were entitled to receive their dividends, and sit still. Under these circumstances Government might have paid the £800,000, and taken the cable into their own hands. But, after full consideration, they determined against that course, thinking that any attempt on their part to raise the cable would involve a risk which they were not justified in incurring. In this state of things a new company came forward and said, "We don't ask for any money or for any guarantee, but we ask you to transfer the property in the cable by Act of Parliament from the old company to us, and allow us to try and restore it. If we succeed we ask you to allow us to derive the profits from the cable up to 25 per cent. upon our outlay, and above that return, the profits will go to reimburse the Government." As this proposal did not involve the risk of a single farthing to the Government, they determined to accept it, and thus, as they thought, to make the best of a bad bargain; and he submitted that next to the folly of throwing £800,000 to the bottom of the sea, would have been the folly of allowing £800,000 to remain at the bottom of the sea when you could get anybody to try and fish it up for you. The transfer of the property in the cable from the old company to the new one was not complete until the passing of this Bill. It was true that an agreement to that effect had been come to between the two companies, but he believed that, legally, the property in the cables remained in the old company till an Act of Parliament was passed. As to the new arrangement with the old company, it was completely set forth in the Bill. There was the transfer of the property, and in exchange for it the conversion of an annual payment of interest into an annuity which would be more negotiable. With regard to the performance of the conditions by the new company, it was directly their interest to raise the cable, and unless they did so they would not get a farthing of return upon their expenditure. He was glad to learn that their operations so far had been attended with considerable success. They had restored the cable up to a point called Djubal on the Red Sea, where they were able to send messages, and anticipate by some hours the advices from India, receiving already for this service a small amount of revenue. He submitted that the form of the Bill was not open to objection; that in substance it was the best arrangement which could be made; and he hoped that, as the time for carrying out the arrangement was short, their lordships would pass the Bill without further delay.

The Earl of CAMPERDOWN understood the Bill to involve the payment of an annuity by the Government for fifty years of £36,000, which would amount to the sum he had before stated. Besides this, in the event of the company's failure to restore the line or maintain it in working order, the Commissioners of the Treasury were to have power to take it into their own hands again on repaying the capital actually expended by the new company. There was also an annuity payable of 4½ per cent. on £250,000 additional capital, which might or might not be expended by the new company. The directors of the new company were pretty nearly the same as the directors of the old company, and from the manner in which they have behaved in the past, he had no great confidence to repose in their future arrangements. The contract ought certainly to be stated in the Bill. The Treasury should not spend money without entering into a legal contract.

The LORD CHANCELLOR considered that they were under this Bill making the best of a bad bargain. The question had been raised on the failure of the old company, whether the Government, having paid so large a sum of money, acquired any lien upon the property of the old company. He thought they did not. The House of Commons had appointed a committee on the subject, and they came to the conclusion—it was their conclusion entirely—that the old company was entitled to have from the Government a guarantee for their dividend. The guarantee the old Act of Parliament gave effect to, but that guarantee and the agreement with Government on which it was founded, did not entitle the Government to any lien on the property of the old company. Well, then, the property was left in the old company in a manner in which it could be applied to no useful purpose. Accordingly, an arrangement was made with the new company. The objection of the noble earl was founded on this; and that objection, in his opinion, was, to a certain extent, rightly founded. The noble earl said they had not set out what was the arrangement between the Government and the new company. It was embodied in the schedule. He then asked where was the obligation thrown on the new company to perform the agreement. He (the Lord Chancellor) thought the Bill deficient in that respect, and he should, therefore, suggest to his noble friend who had charge of the Bill, at the end of the first section, which concluded thus, "that the agreement of the 18th of November, 1858, and all covenants and conditions contained therein, shall be deemed at an end," to add these words, "but the new company shall be bound to fulfil the covenants contained in the schedule annexed. He thought the new company would then be bound and rendered capable in law of performing the agreement.

The words were then added.

Lord OVERSTONE thought the Government in this case were perfectly right, and were proceeding upon an arrangement founded upon a reasonable consideration, and with a proper regard to the public interests.

Earl GREY admitted that there was no objection in substance to the agreement. The Bill was at first objectionable from the vague manner in which it was drawn; but in its amended shape, and with the addition proposed of the noble and learned lord on the woolsack, it was substantially unobjectionable. He, however, still thought it would have been better if there had been a clear contract made with the company and set forth in the Bill.

The report was then received.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

SIR,—Can you or any of your readers explain the causation of the following phenomenon observed in the electro-deposition of metals. Placing

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a galvanometer in circuit when the operation is going on, we may observe the power of the current under any given circumstances. If we wish to increase the amount of electricity in order to produce an increased effect, we may do so either by augmenting the number of couples or by increasing the surface of the elements. But the results obtained are very different in either case, as seen in the quality of the metal deposited. If the size of the plates is increased beyond a certain degree, the metal is often deposited without coherence, and in a rough powdery condition; if the intensity be too high, a brittle crystalline deposit is obtained. Yet in both cases there may be the same deflection of the galvanometer in circuit. The cause of these effects has not, as far as I know, been explained. The explanation would doubtless involve many interesting and important facts in relation to the action of voltaic electricity, and might be of more service to the manufacturer in enabling him to produce at will, with certainty, any desired effect. In the absence of theoretical guidance, considerable experience is necessary to regulate the battery in the processes of electro-metallurgy. INVESTIGATOR.

To the Editor of THE ELECTRICIAN.

SIR,—In the House of Lords of Thursday, June 26, occurred one of the usual little discussions, which their lordships like to indulge in whenever the Red Sea Company's Bill is brought forward. It must be rather amusing to those who are conversant with the history of the Red Sea Telegraph, to watch the attempts of their lordships to show the public their determination that no further improvident contracts shall be shuffled through this House. This extreme caution on the part of their lordships would be exceedingly praiseworthy and useful, if it could only have been brought to bear on the subject three or four years ago. But as the £800,000 which was so quietly handed to the Red Sea Company to spend has been duly spent, and no effort of their lordships can possibly recall it, it is rather late to haggle over the Bills now before Parliament, which merely consist of the formal transfer of the Red Sea wreck to another company. In fact, is it not very much like gravely deciding whether it would be better to put a Bramah or a Chubb's lock on the stable door after the horse has departed? ACUMEN.

Miscellanea.

OZONE.—In a letter to Professor Faraday, Schönbein writes:—"After many fruitless attempts at isolating ozone from an ozonide, I have at last succeeded in performing that exploit; and have also found out simple tests for distinguishing with the greatest ease ozone from its antipode, 'antozone.' As to the production of ozone by purely chemical means, the whole secret consists in dissolving pure manganate of potash in pure oil of vitriol, and introducing into the green solution pure peroxide of barium, when ozone, mixed with common oxygen, will make its appearance, as you may easily perceive by your nose and other tests. By means of the ozone so prepared, I have rapidly oxidized silver at the temperature of 20° C., and by inhaling it produced a capital 'catarrh.'"—*Philosophical Magazine.*

WHAT BECOMES OF THE ARSENIC USED IN CALICO PRINTING?—Now comes a curious feature of the operation, which startles one at first as a means of cleansing the cloth. It is necessary, if you will allow me to use the expression, to scour the surface of the cloth in order to make it clean enough for the purpose of the calico printer. You recollect that these mordants have been put on by means of thickeners of gum and various other materials, and it is necessary to remove all these thickeners and other substances by scouring the surface of the cloth, so that the printer can use it. Now, if nothing more than this was required, it would be sufficient to pass this printed material through ordinary hot water, and that would take off the thickeners and leave the cloth in the proper state; but that is not sufficient, and for this reason; all the mordants are not decomposed in the process of ageing. Some of them still remain in a soluble state, and if you simply used a bath of hot water, the soluble mordants would attach themselves to the portions of the cloth which are to be left white, and would foul them, so that in dyeing, the cloth would be smeared over by the portions of the mordants thus dissolved. To prevent this the calico printer made use of a curious process, which was to pass the cloths through baths in which the dung of cow-houses was placed. In this way all the soluble mordants were converted by the cow refuse into insoluble substances, which could no longer attach themselves to the cloth and cause a confusion of colours. In consequence of this operation large dairy establishments were connected with print works, so that the printer might have a sufficient quantity of cow refuse for his purpose. After a time, when the action of this substance began to be properly understood, chemists asked themselves whether some substitute could not be used, so that this objectionable process might be dispensed with. They soon discovered that the peculiar action of this refuse upon the mordants was due to the phosphates which it contained to a considerable extent; and it was then easy to make artificial phosphates—phosphate of soda and phosphate of lime—and these were mixed together with glue, and sold for a long time under the name of "dung substitute." Within the last few years chemists have found that even these phosphates are not required, and that it is better to use arseniate of soda—arsenic acid united with soda. You may have some idea of the enormous quantity of this highly poisonous salt that is used, when in Lancashire alone 500 tons of this arseniate is annually made for the purposes of the calico printer. The use of this substitute has a great advantage. The material is added to the bath, and you may pass several thousand pieces through the same bath, by adding a little additional arseniate of soda. The same bath may thus be used for several thousand pieces without being changed; but in the old plan, where cow dung was used, it was necessary to change the bath after a few pieces had been passed through it, so that the application of these phosphates and arseniates to the purposes of the calico printer, has enormously aided him in diminishing the necessity for labour. I am, however, sorry to say, that calico printers do not know what to do with the waste of these arseniate baths after they have used them, and they require changing; and, in order to get rid of this arseniate, they have turned it into the nearest stream in the neighbourhood of the works; and then this stream passes in course of time into the reservoirs in which the water is stored for the purpose of being supplied to the inhabitants of the district; so that they are obliged to drink the arseniate which the calico printers have used. Only a few months ago I was sent down to Stockport, in Cheshire, where they suspected that they were drinking arsenic in the water supplied to them. The town is supplied with water from streams which have passed some print works. The mud of the reservoirs was highly charged with arsenic and lead, and the water which the inhabitants drank had arsenic in it, but in such a small quantity that it was not hurtful. This practice of throwing the arseniates into the streams cannot be too highly reprobated. As calico printing is increasing, these poisonous materials are also increasing in their consumption; and however we may wish to allow manufacturers to proceed without any legislative interference, it is clearly quite wrong that they should think so slightly of the health and life of the rest of the population, as they appear to do when they pour these poisonous materials into our streams.—*Dr. Lyon Playfair.*

PURIFICATION OF WATER BY ELECTRICITY.—A most ingenious application of electricity for the purification of water has recently been made known by Dr. Phipson. We do not suppose that this process will be much employed by our readers, but still it is possible to conceive that cases might arise in which such a method of getting rid of the impurities in water might be of great value. The doctor says, that reflecting upon the powerful decomposing chemical force with which we are furnished by the voltaic pile, it occurred to him that we might be able to render sea-water potable by decomposing and extracting its salt by means of a moderately powerful battery. The experiments were made at Ostend a few years ago. The apparatus consisted of three vessels containing sea-water, the centre one contained the water to be operated upon, the two others communicated with the two poles of the battery. The three vessels were connected by two bent ∩ tubes filled with sea water. As the only battery procurable at Ostend was rather weak, the current was passed through the water for about fourteen hours, after which one of the outside vessels had become acid and the other alkaline. The sea-water was then filtered through charcoal, and was nearly drinkable. It would have been, doubtless, quite potable, had the battery employed been more powerful, but with the one in use it was found difficult to extract the last portions of salt, and the water, after subsequent trials, still presented a slightly brackish taste. Dr. Phipson has not since had an opportunity of repeating this experiment, but from the results obtained it is quite possible that sea-water might be rendered potable by means of the electric current. This reminds us of Sir Humphrey Davy's memorable experiments upon the production of fixed alkali by the electrolysis of water. Upon electrolysing the purest water that could be procured, placing it in two cups connected together by threads of amianthus, it was always found that the water in the negative cup gained the power of giving a slight blue tint to litmus paper—the water in the positive tube rendering it red. This had been noticed by many English and foreign chemists, and some of them had expressed the opinion that there was a veritable production of acid and alkali by the electricity. After a great number of experiments, conducted with the most minute precautions, Sir Humphrey Davy read a paper before the Royal Society, in November, 1806, in which he proved that the acid and alkaline bodies were derived from a minute trace of soluble salts, which had been dissolved by the water from the glass, &c., in which it was distilled, and which the electricity had decomposed in the manner mentioned above by Dr. Phipson.—*Photographic News.*

To Correspondents.

A. F.—Aluminium has not been obtained in a separate form by electrodeposition, although from a solution of the chloride a surface deposit takes place upon copper. The problem is one of interest and importance, and providing you have a sufficient knowledge of the conditions involved, there is no reason why you should not attempt its solution. If we knew of such a menstruum as that you require, in which the salt could be dissolved, we should probably ourselves have obtained the desired result.

H. WILBERFORCE.—You should employ a greater number of cells, of smaller dimensions, arranged for tension. The magnets should have been coiled with stouter wire if you intended to accommodate the instrument to your battery; but you will find it nearly as convenient, and quite as economical, to use 8 or 10 smaller cells.

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The Electrician.

VOL. II. No. 36.—JULY 11, 1862.

CONTENTS:

	PAGE
Telegraphic Projects	109
Some Considerations on the Principles of Electrical Conduction and Accumulation	109
Tornadoes and Waterspouts	111
Gutta Percha and India Rubber	112
The Student	112
Carbonic Oxide and Nitrogen	114
On Nerve Force—Relation of Nerve Force to Electric Force—Origin of Nerve Force	114
On the Electromotive Force of Voltaic Piles	116
Application of Galvanic Electricity to the Treatment of Diseases	117
Obituary Notice	117
On the Production of Electric Light for Photographic Purposes	118
Prices Current of Insulating Materials	118
Telegraph Shares	118
Telegraphic News	118
Recent Patents	119
Correspondence	119
Miscellanea	120
To Correspondents	120

TELEGRAPHIC PROJECTS.

FROM a paragraph in our last issue, headed "Anglo-Australian and China Telegraph," it will be perceived that the promoters of this enterprise, although not yet incorporated as a Company, are taking active steps towards the realization of this most important project. The proposed line, extending from the terminal point of the Indian telegraphic system at Rangoon to Moreton Bay, in Queensland, Australia, with the branch line from Singapore, *viâ* Saigon, to Hong-Kong, will extend over more than 5,900 nautical miles, exclusive of the sections already completed from Singapore to Batavia, and thence to Cape Sedano; the whole being submarine, and, with the exception of the section across the Gulf of Carpentaria, in shallow water. Moreton Bay, nearly the most easterly point of the Continent of Australia, is, it will be remembered, already united by a stretch of overland wire with Adelaide, Melbourne, and Sydney, and, by a submarine wire, also with Van-Dieman's Land. Thus the line in question would bring our Australian colonies into almost as close proximity to Great Britain, as regards the transmission of intelligence, as our Indian possessions. We understand that very heavy cable will generally be employed; the soundings, in most cases, giving but a comparatively small depth of water, and showing a rocky bottom. The repair of the cable, when necessary, would present but little difficulty throughout nearly the whole length. It is anticipated that a subsidy will be granted by the French Government towards the completion of the branch line, *viâ* the French settlement at Saigon, to Hong Kong; but there is reason to believe that in the present condition of French finance the aid that would, under other circumstances, be rendered to telegraphic enterprise, must of necessity be deferred. There is, however, a choice of routes in establishing communication between Singapore and Hong Kong, and it is possible that the line touching at Sarawak, in Borneo, and Manilla, in the Island of Luzon, might be found preferable.

The proposed submarine line from Tripoli, *viâ* Susa, to Bona, along the northern coast of Africa, will probably form the first endeavour of the French Government whenever their exchequer may be in a fit condition to carry out their plans for telegraphic extension. The line would prove of the utmost importance to the settlement of Algeria, giving the opportunities for commerce which are so much wanted to render Algiers something more than an unprofitable outlet for the surplus military energies of France. Its establishment has been latterly under fresh consideration.

The Italian Government has decided upon connecting the island of Sardinia with Sicily. The length of the submarine line will be about 200 miles. The contract for the execution of the works has been concluded with Messrs. GLASS, ELLIOT, and Co. This line is likely to prove particularly useful, as affording a supplementary means of communication with the East when the Italian overland wires, as frequently happens, become from any cause disabled.

The arrangements of the Atlantic Telegraph Company appear now to be sufficiently matured to enable them very shortly to renew active operations for the completion of the enterprise. On the part of the British Government, the vessels for laying the cable will be furnished, and a guarantee of 8 per cent. for 25 years will be given upon the capital of £600,000—conditional upon the successful laying and working of the cable. The American Government has undertaken to give a further subsidy of £14,000 per annum, also conditional upon success. The company possesses exclusive rights to land cables in Newfoundland, upon the coast of Labrador as far as Ungova Bay, in Cape Breton, in Prince Edward's Island, and on the coast of Maine. They have also exclusive agreements with all the telegraph companies in America, whereby the latter undertake not to connect their lines with any other transatlantic cable that may be laid. In most cases, the American companies have agreed to forego in favour of the Atlantic Telegraph Company 40 per cent. of their inland tariff upon all messages to or from the States of America. In virtue of several Acts of Parliament the company is empowered to land the cable in Ireland, England, or any point on the Continent which may be suitable and expedient for their purpose, and the Lords Commissioners of the Treasury are enabled to make any increase in the amount of the subsidy, or to give any further guarantee that they may consider advisable.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 99].

BEFORE the subject can be further discussed, it is necessary to enter a little on the subject of the laws of electrical repulsion and attraction, for on these phenomena depend some of those instruments called electrometers, for detecting the presence of electricity, and for measuring the electrical energy with which the electricity of any source, or on any charged conductor tends to pass to a surface of given area under given conditions for accumulation.

The attraction of two bodies oppositely charged, and the apparent repulsion of two bodies similarly charged, are too well known as mere facts to require repetition here. It is not my intention to venture on any theory of the actual nature of the force exerted, but only to attempt to trace the relations which exist between the attractive force, distance, quantity, &c.; how these relations may, to some extent, be accounted for; and also to call attention to some of the experiments on this subject, and the laws which have been deduced from them.

If two small insulated balls be charged with equal quantities of opposite electricity, and placed near one another, and far from surrounding objects, they will be attracted towards one another with a certain force which may by careful means be measured. If placed at a greater distance from one another, this force will be decreased, and if nearer increased. If the two insulated balls are maintained at a constant distance, and the quantity on them only altered; then an alteration in the attractive force will result. Coulomb found *the attractive force to vary as the product of the two quantities*; so that if the quantities on the two balls were constantly equal, the attractive force would vary as the square of the quantity on one ball. Thus, if a certain quantity of electricity be imparted to one ball, and taken as a unit of quantity, and an equal quantity of electricity of opposite name to the other, and their attraction force then, measured and called unity, then, if the quantity on each were doubled, the attractive force would become $2\times2=4$ (or 2^2), if trebled $3\times3=9$ (or 3^2), if quadrupled $4\times4=16$ (or 4^2).

Sir W. S. Harris has also performed experiments on the ratio between quantity and attractive force, which, although in a dif-

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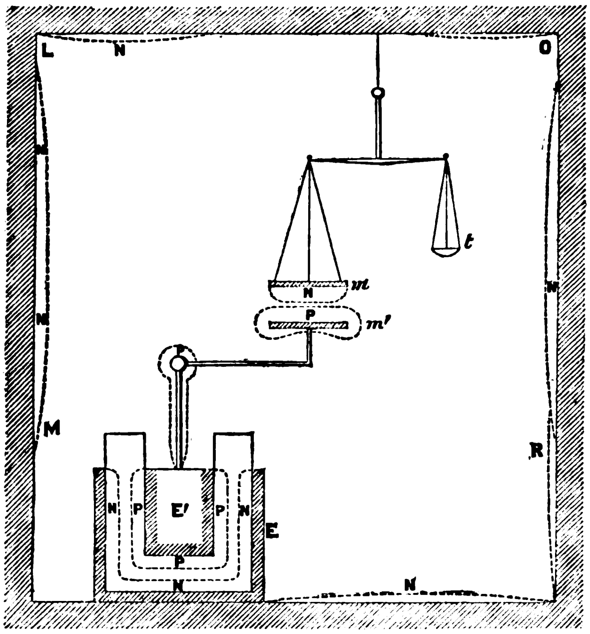
ferent form to those of Coulomb, tend to the same result, and may be thus described :—

A Leyden jar E (fig. 76) has its interior coating E′ connected to the disc *m′*, above this disc is situated another disc suspended

Fig. 76.



from the beam of a delicate balance, to the other end of which is suspended a scale pan, *t*, into which weights can be placed to counterbalance any attractive force exerted between the discs *m* and *m′*. The upper and suspended disc was in connection, through the scale beam and supports, with the outer coating of the jar E.

A certain quantity was then communicated to the jar E,* "the attractive force of which operating between the two plane surfaces, *m m′*, was equivalent to 4.5 grains."

"When the quantity of electricity accumulated was doubled, the force amounted to exactly 18 grains; three times the accumulation balanced a force of 40.5 grains, and so on."

"When a second and precisely similar jar was connected with the former, so as to double the extent of coating, similar quantities, measured as before, only exhibited one fourth of the previous forces respectively."

Now, let us analyse this arrangement. Whenever a certain quantity was communicated to the interior coating E′ and the disc *m′*, an equal quantity of opposite electricity must of necessity have been distributed on the outer coating E, the disc *m*, and any other conducting surfaces surrounding *m′*, such as the surrounding surface M L O R. The distribution would, therefore, take place according to the inductive resistance separating the two opposite charges; the greatest quantity would, therefore, be distributed on the surfaces of the jar, and a certain quantity on the proximate sides of the discs, a small quantity being also resident on the under side and edges of the disc *m′*, having its opposite quantity on the surrounding objects. But whatever would be the proportionate distribution, it would be the same, whatever the total quantity; so that when the total quantity is doubled or trebled, the quantity on the proximate sides of the discs is doubled or trebled.

Now, it is evident the quantity on the surfaces of the jar does not tend to attract the discs towards one another; nor does any of the quantity that is maintained on the lower disc *m′* by the action, to the surrounding objects, since this only tends to attract the immoveable disc in every direction towards those objects on which the opposite state exists.

The attractive action between the discs *m* and *m′* is, therefore, the result of the two equal and opposite quantities on their proximate surfaces. We thus have two equal and opposite quantities acting on one another, and when we double the total quantity on the whole system, since the distribution remains the same, we double these two equal and opposite quantities. The attractive force may be said, therefore, to vary as the *product of those two equal quantities, or as the square of the quantity on the uninsulated disc only.*

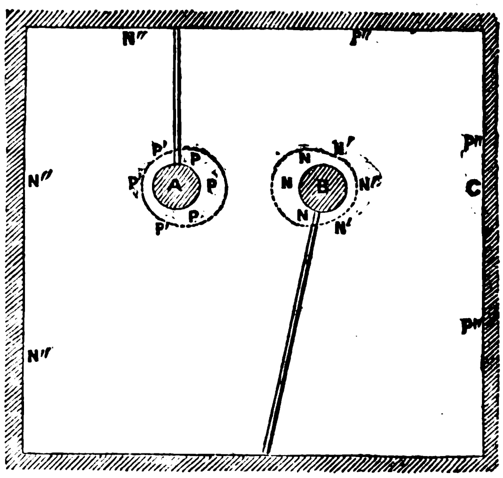
In this experiment, it will be observed we are only testing the attractive force of a small portion of the successive quantities which we communicate to the whole arrangement; but, as that portion is always the same fractional part of the different charges, it is immaterial whether we call the quantity on one of the discs actually attracting unity, or the total quantity of electricity of one name communicated to the whole system. Therefore, the attractive force varies, either as the product of the quantities on the discs actually attracting, or as the product of the different opposite charges communicated to the whole of the two surfaces, or as the square of the different quantities of one electricity communicated to the system.

In fact, the total quantity communicated, in this experiment, bears constantly the same proportion to the quantity whose attractive force is measured.

If the lower disc is not connected to a Leyden jar, but has a certain quantity imparted to it, and then this quantity doubled, or trebled, or halved, the same relation between the total quantity and the attractive force will result, provided the upper disc is uninsulated. For the attraction will still be due to the attractive force between two equal quantities, one on the lower part of the upper disc, and the other on the upper part of the lower disc, and as the distribution will be the same whatever the total quantity be, these two equal quantities will constantly bear the same ratio to the total quantity imparted to the insulated disc.

In Coulomb's experiments, since both balls were insulated, a certain charge was always communicated to each ball. Suppose A and B (fig. 77) to be the two balls, A fixed, and B that attached to the

Fig. 77.



tension balance arm; and let a charge of positive be communicated to A, and an equal charge of negative to B, then the quantity on each ball would distribute itself according to the inductive resistance separating each ball from the other, and from the surrounding surface. Certain equal quantities P P and N N would be maintained on the proximate sides of the balls therefore by the direct action between them, and certain quantities P′ P′ P′ and N′ N′ N′ on the surfaces of the two balls

* *Philosophical Transactions* for 1834, page 221.

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by the indirect action to the surrounding surface, which would become polarized, having one portion P″ P″, &c., positive, and the other N″ N″ negative. Now it is evident that that portion of the charge on B, which is maintained by the action to the surrounding surface, tends to draw the ball in almost every direction, except in the direction of the ball A. All the electricity represented by N′ N′ N′ is in fact attracted towards its opposing electricity P″ P″.

The resultant of these forces constitutes a force tending to move the ball B towards C. The remaining portion of the quantity on B, tends to move the ball B towards A, on which is its opposing quantity towards which it is attracted. The force tending to move the moveable ball is therefore the *difference of these two electrical attractions* in opposite directions: and if the ball B, is within a certain distance of A, as compared to the surrounding objects, the distribution will be such that the difference of these forces will be in favour of the attraction towards A.

If this force is measured, and the quantity then doubled on each ball, then, since the position of both balls and surrounding objects remains the same, the distribution will be the same; all the quantities are doubled, so that if we double the quantity tending to separate them, we also double the quantity which attracts them to one another, and we therefore double their difference. If the attractive force is then measured, it is found to be four times as great as before, or in fact, to vary as the product of the quantities, or as the square of the one quantity.

The action in this case is, therefore, a complex one, and is not the result of the attraction between the whole charges on those spheres, but is the result of the difference of the attractions in different directions, this difference varying as long as the distribution remains the same as the square of the quantity on one sphere. This relation between the *total quantity on the spheres* and the *total attractive force*, only holds good, however, as long as the distribution remains constantly the same, for if we cause an alteration in the distribution, we may vary the attractive force between the balls, indeed, entirely reverse it, without any alteration in the total quantity on them. If, for instance, we alter the position of the surrounding surface, as by approaching the surrounding objects to B in the direction of C. Then, as the resistance of the indirect inductive circuit will be decreased, whilst the direct one remains unaltered, a redistribution will take place, and some of the electricity on the proximate sides of the two balls will pass to the other parts, in accordance with the new resistances. The direct attraction between B and A will be decreased, whilst the attractions in the direction B C will be increased, without any alteration in the total quantity on B or A. The resultant, or difference, between these two forces will no longer, therefore, be the same as before, although the quantity on the balls remains the same.

The same effect could be produced in Sir W. S. Harris's arrangement; for if the Leyden arrangement were made suddenly thinner or thicker, or even if an uninsulated body were approached to the lower side of the fixed disc (m'), a redistribution would take place, and the quantity on the proximate sides of the two discs would become altered, the attractive force would, therefore, become altered without any alteration in the total quantity in the whole system.

As long, however, as the system and the position of all the conductors remains the same, the distribution will be the same, and, consequently, if we double or treble the total quantity, we double or treble the quantity on every part.

In Harris's arrangement with the moveable upper disc in connection with the outer armature of the Leyden jar, we have such an arrangement that *all* the electricity on the upper disc attracts that disc in one direction, viz., towards its opposite electricity on the lower disc, so that the attractive force is due to the quantity on the upper disc m, without any deduction since it all acts in one direction, viz., towards the lower disc. This experiment is much the simplest and most conclusive experiment therefore on the relation between quantity and attractive force, since we see that in Coulomb's the force must be the resultant of several forces acting in different directions.

(To be continued.)

TORNADOES AND WATERSPOUTS.

It is generally admitted that these destructive phenomena arise from the effects of electrical attractions and repulsions occurring on a scale of vast magnitude in the atmosphere, and between the atmosphere and the earth. The following extract from a report of the French Academy of Sciences in 1839, is instructive in regard to the first-mentioned of these overwhelming manifestations of electrical force, which are happily so rare in this country.

"Up to this time there had been thunder continually rumbling within the second thunder-cloud, when suddenly an under portion of this cloud descending and entering into communication with the earth, the thunder ceased. A prodigious attractive force was exerted forthwith, all the dust and other light bodies which covered the surface of the earth mounted towards the apex of the cone formed by the cloud, a rumbling thunder was continually heard. Small clouds wheeled about the invested cone, rising and descending with rapidity. The column was terminated by a cap of fire. To the south-east of the tornado, on the side exposed to it, the trees were shattered, while those on the other side of it preserved their sap and verdure . . . . . finally it advanced to the park and castle of Chatenay, everthrowing everything in its path. On entering this park, which is at the summit of a hill, it desolated one of the most agreeable residences in the neighbourhood of Paris. All the finest trees were uprooted, the youngest only, which were *without* the tornado, having escaped. The walls were thrown down, the roofs and chimneys of the castle and farm house carried away, and branches, tiles, and other moveable bodies, were thrown to a distance of more than five hundred yards. Descending the hill towards the north, the tornado stopped over a pond, killed the fish, overthrew the trees, withering their leaves, and then proceeded slowly along an avenue of willows, the roots of which entered the water, and being during this part of its progress much diminished in size and force, it proceeded slowly over a plain, and finally, at a distance of more than a thousand yards from Chatenay divided into two parts, one of which disappeared in the clouds, the other in the ground."

The following is the explanation of these phenomena offered by Peltier:—

"In contemplating the rise and progress of this phenomenon we see the conversion of an ordinary thunder gust into a tornado; we behold two masses of clouds exposed to each other, of which the upper one, in consequence of the repulsion of the similar electricities with which both are charged, repelling the lower towards the ground, the clouds of the latter descending and communicating with the earth by clouds of dust, and by the trees. This communication being once formed, the thunder immediately ceases, and the discharges of electricity take place by means of the clouds, which have thus descended, and the trees. These trees traversed by the electricity, have their temperature in consequence raised to such a point that their sap is vaporized, and their fibres sundered by its efforts to escape. Flashes, and fiery balls, and sparks accompanying the tornado: a smell of sulphur * remains for several days in the houses, in which the curtains are found discoloured. Everything proves that the tornado is nothing else than a conductor formed of the clouds, which serves as a passage for a continual discharge of electricity from those above, and that the difference between an ordinary thunder-storm, and one accompanied by a tornado, consists in the presence of a conductor of clouds, which seem to maintain the combat between the upper portion of the tornado and the ground beneath."

The following account of the ravages committed by a waterspout at Cette, appeared in the *Times* of October 30, 1844:—

"A frightful misfortune has this afternoon plunged our whole population into a state of consternation and despair. About four o'clock an electric waterspout fell upon our town, and committed such ravages, that at the present moment it might be supposed that the town had been submitted to all the horrors of a siege. This terrible phenomenon, which arrived in the direction of the fortress of St. Pierre, skirted the mole in its whole length; and when it came opposite the engineers' establishment, attracted probably by the conductor

* Rather, of ozone.—ED. E.

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and the zinc roof of the house, it turned round the edifice, and at last fell with violence upon it. At the same moment a violent explosion was heard, and the whole population thought that its last hour was come. During two minutes' space of time a terrific crash resounded in the air. The roofs of the houses were smashed to pieces, and the fragments were carried to the most distant part of the town. The building belonging to the engineers has been entirely sacked; its zinc roof was carried off in the twinkling of an eye, and the whole façade demolished and razed to the ground, so that nothing now remains of it but the back and side walls. Another house, four stories high, new, and solidly built, was literally crushed to the earth. In every apartment the separation walls were destroyed, and the windows torn out; everywhere destructive traces have been left. A fearful inundation joined at the same time its ravages to those of the electric waterspout. In an instant the waters of the canal rose and flooded the quays. At least a dozen boats were sunk in the canal itself, and many persons perished. Five or six large vessels have been completely wrecked, and remain with their keels uppermost. In the streets and on the quays are everywhere to be seen wounded wretches, some with bloody heads, others with mutilated limbs. It is impossible to give any description of the feelings of terror produced in the minds of the whole population."

The following are the conclusions arrived at by Peltier from his investigation into the causes of waterspouts.

"1. All the immediate phenomena observed in waterspouts are due to electricity. They are the results of secondary phenomena, which almost always accompany them. The latter vary with the locality and the state of the atmosphere.

"2. Their general effects are due either to statical or dynamical electricity: more generally they proceed from both.

"3. The statical effects are phenomena of attraction and repulsion.

"4. The attraction of an electrical cloud is accompanied by a rush of air towards this cloud, from whence result currents directed from the exterior to the interior, and proceeding from all surrounding points. It is manifested also by the projection of the vapour of water, of liquid water itself, and of bodies that it raises or tears according to the force with which it acts.

"5. The progress of its attractive power is plainly marked both on sea and land. On sea it appears by the boiling of the waters, and the smoky appearance which is raised from them. On land its course is rendered manifest by its effects upon the air, the ground, and all loose bodies which it encounters.

"6. The attraction of the clouds is also manifest by the greatly increased evaporation of the waters, and the consequent fall of their temperature. The repulsion is manifested by currents of air which issue from the electric cloud, and only exist in its neighbourhood; at a little distance from it a dead calm prevails. These double currents undergo various modifications produced by the localities and the various qualities of the ground.

"7. The repulsion is also manifested by the cone which is formed in the sea, in the very centre of the smoky vapours, an effect which can be easily reproduced experimentally.

"8. If an inductive action take place between two clouds charged with opposite electricities placed at a certain distance asunder, a portion of their vapour will resume the state of common vapour; this will lower the temperature of neighbouring parts, which may descend even below the freezing point; then the vapour of water crystallizes in snowy flakes, which act, immediately after their formation, like other light bodies. The portion thus transformed into snow, and which is charged with the electricity of the inferior cloud, is attracted by the superior cloud, then there is a neutralization of electricity, a fall of temperature, and so on.

"9. Finally, the electrical tension of the superior cloud facilitates the evaporation of the liquid which moistens the snowy globule or which already covers the ice. The electrified clouds acting by induction upon the ground are attracted to it. The clouds thus approach the earth in a greater or less quantity, depending on the energy of the attraction and their specific gravity."

The sound which sometimes accompanies the tornado, Peltier ascribes to a number of small partial explosions, which take place between the cloud and the ground. They are louder in the case of waterspouts which traverse the land, because of the badness of the conductors presented to them; they lose their intensity over the sea because water is a better conductor. In short, there is nothing but electricity, and electricity of prodigious tension, which can produce effects so violent, within limits so very confined, while leaving the surrounding places calm.

GUTTA PERCHA AND INDIA RUBBER.

[From the *Chemical News*.]

FEW branches of manufactures have in as many years assumed the importance, and received the same development, as that of india rubber and gutta percha. Within the memory of most middle-aged persons, india rubber was a curiosity, and its only use was to erase pencil marks, the general impression among school boys at the time being that it was obtained from the elephant's trunk. Gutta percha then had not been heard of in this country. Now, extensive factories in many parts of England and in Scotland, employing in the aggregate several thousands of hands, are working them up into materials so useful that many have become necessaries, and the prospect of a stoppage in the supply of either india rubber or gutta percha would create a panic. Considering the increasing number of applications which india rubber is still receiving, it behoves manufacturers to look well to the sources of supply, which may also, perhaps, be susceptible of increase. A considerable amount of caoutchouc, or caoutchoucous matter, which might be available for the coarser materials, such as kamptulicon, is annually thrown away by wholesale druggists and others who make some vegetable liquors, such as liquor rhei, and, as we believe is sometimes done, extract of opium from Egyptian opium. The quantity, perhaps, is not very large, but it might be worth preserving.

The first place in this department of the Exhibition is due to Mr. Mackintosh, who may be called the father of india rubber industry. In a grand case (1101) Messrs. Mackintosh and Co. exhibit specimens of all their productions, including copies of the books Mr. Mackintosh has written about india rubber. It is unnecessary to say that everything looks as good as it can be; but there does not appear to be any novelty calling for particular notice. Mr. Hancock, as the inventor of vulcanised india rubber, deserves the next mention. In his case (1079) will be seen all kinds of productions in vulcanised rubber, which appear fully to justify Mr. Hancock's position in the trade. In the case of the North British Rubber Company (1109) will be seen many articles in the material, which, for neatness and finish, have never been excelled. The overshoes, for example, greatly surpass in lightness and appearance any of the American importations we have seen. Close by (1121), the Scottish Vulcanite Company exhibit numerous applications of the material of Mr. Goodyear's invention—vulcanite, or ebonite. This material has not yet received all the applications of which it is susceptible; but there are many elegant and useful articles in this case, one of whose great recommendations is their indestructibility. In 1146 Messrs. Warne and Co. show some novel and important applications of this substance. They have succeeded in uniting in one piece the soft ordinary vulcanised rubber and the hard indestructible vulcanite, and adapting the "junction rubber"—as they call it—for valves, pump-buckets, hydraulic ram rings, and many other purposes. These valves and buckets must necessarily have much greater durability than those made of ordinary vulcanised rubber alone. There are many other things, of more interest perhaps to engineers than chemists, but there is a ferruginous cement packing which deserves a notice, and which may be useful to some of our manufacturing readers. For all permanent joints, the inventors say that this material (elastic before its application) can be made to set as hard as iron, and it will expand and contract in the same ratio as the metal; while for other joints it can be made sufficiently elastic to answer all the purposes of india rubber or other packing. There are exhibited, also, the ingenious applications of mineralised india rubber to flesh and clothes brushes, with which most of our readers are familiar. Altogether, this case, which is placed in a situation where it is very likely to be passed without notice, must be considered the most interesting in this department of the Exhibition. In 1125 Messrs. Silver and Co. have likewise a good display of articles in vulcanised rubber and ebonite; and in 1059 Messrs. Cow exhibit a collection of useful articles of their well-known excellence of manufacture.

Gutta percha may be seen in the class in all conditions, from the raw material as imported, to the completely purified article of Dr. Cattell. 914. This latter is a beautiful article, and we fear it is too good to receive many applications; but the doctor deserves great praise for bringing its production to such a state of perfection. In 1078 the Gutta Percha Company exhibit most of the useful articles they make, such as bottles, cells, and troughs for batteries and photographic baths. These are too well known to require any notice. Mr. Hancock's grand ornamental applications of gutta percha to a large oak sideboard will be sure to attract the attention of the visitor, and will also receive his commendation.

The Student.

THE MAGNETO-ELECTRIC MACHINE.

THE first rotating magneto-electric machine was constructed by M. H. Pixii, of Paris, about the year 1832. In this a powerful magnet, disposed horizontally, was made to revolve in close proximity to an armature, on which was coiled about 1,000 yards of fine wire; sparks being produced by the vibration of one of the terminals of the coil dipping into a cup of mercury. The next, and that best known in

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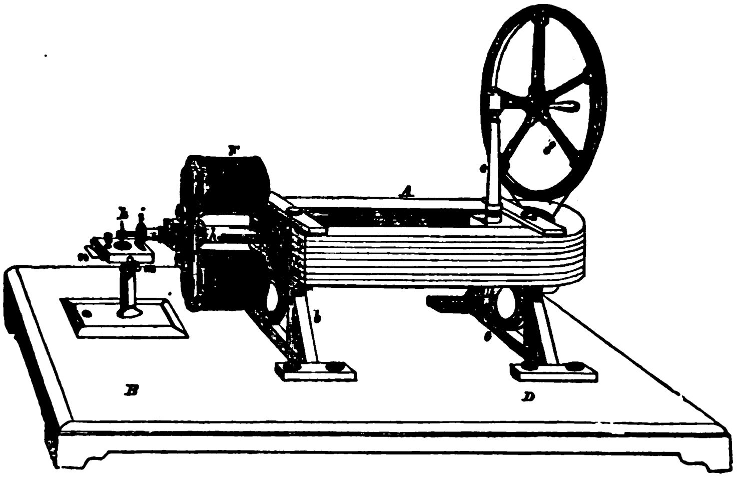
this country, is that of Mr. E. M. Clarke, in which a battery of magnets was made to revolve in a vertical instead of a horizontal position. In Clarke's machine two soft iron armatures were used, the first coiled with 40 yards of thick bell wire, and used for quantity effects, the second with 1,500 yards of fine wire, and giving currents of high intensity. A more perfect arrangement is that of Saxton, in which the armature and not the magnet is made to revolve. The following wood-cut represents Saxton's machine. The spindle *h*, to which the

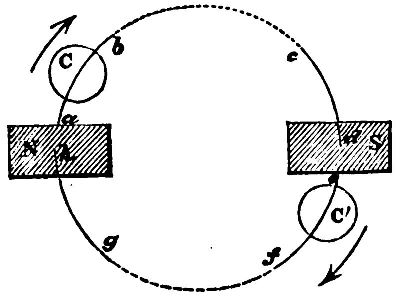
Fig. 1.



armature is attached, can be made to revolve with great rapidity by means of the multiplying wheel *f*. One of the terminals of the wire wound upon the armature F, is connected to the disc *i*, rotating in contact with mercury; the other terminal, insulated from the former, being connected with the cross piece *k*, also dipping into mercury contained in a second cup shown in the figure. The two cups being connected by means of the wire fork *n*, brilliant sparks are produced by the alternate making and breaking of the circuit by the cross-piece *k*. Other arrangements, which appear unnecessarily complicated, were adopted for obtaining a succession of alternate currents, and when a current was required in one direction only, one-half the power of the machine was sacrificed, the currents occurring in this direction only being eliminated.

If we can only bear in mind the successive actions which occur during a revolution of the armature we shall be enabled readily to construct a *commutator*, or current-charger, which will give us the whole power of any instrument we may construct in a succession of currents in the same direction, as required when the magneto-electric machine is made to replace a voltaic battery. During a revolution of the soft-iron armature, we virtually, by magnetic induction, first introduce a magnet into the interior of the wire coil, then, by removing the core from the inductive influence, we virtually remove the magnet; thirdly, we magnetize the bar of iron in the opposite direction; and lastly, we again remove this magnet. Referring to the first paragraph of our article last week, we find that four currents are produced by these means, and that two currents occur successively in the same direction. This will, perhaps, be rendered more clear by the consideration of the following figure, in which N and S represent the poles of a permanent compound magnet, and C and C′ the two extremities of the soft-iron core within the coils of wire wound as upon an electro-magnet.

Fig. 2.

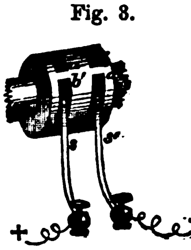


Supposing the armature to be revolving in the direction indicated by the arrows, it would, in the position in which its extremities C and C′ are represented, be *losing* the magnetic polarity in virtue of which the extremity C had become a south pole by induction, and a current will be produced in the coil in a determinate direction. When C, after traversing the arc *a b*, reaches the arc *c d*, it begins to *acquire*, and subsequently fully obtains, an *opposite* polarity, *i. e.*, becomes a north pole by induction, and a second current in the same direction as the former now obtains. During one-half revolution, therefore, two currents in the same direction have occurred. When C traverses the arc *c f* it *loses* this magnetic polarity, and a reverse current is produced in the coil. It is evident that when C *acquires* a contrary polarity, while traversing the arc *g h*, a current in the same direction as the latter will take place.

Let us now give our attention to the following representation of the current-changer, which we may, when necessary, attach to the extremity of the axis or spindle carrying the revolving armature. It consists of a cylinder of ivory or wood, to which are attached two interrupted rings of metal, the separate portions of which are marked by the letters *a a′ b b′*.

If, now, one of the terminals of the coil be made to communicate with *a*, and also with *a′*, the other being connected to *b* and *b′*, it is obvious that if the commutator be so disposed upon the spindle that the interruptions in the contact of the springs *s* and *s′*, may take place at the periods when the direction of the induced currents changes, a succession of currents *in the same direction* will be obtained in a circuit of wire attached to the binding screws represented in the figure.

Fig. 3.



We have yet to advert to a very important application of the fact that the effect of the magneto-electric induction by means of an open magnet is increased when the magnetic circuit is completed by the application of an armature uniting the poles of the magnet. The principle has been adopted in the Globe telegraph of Mr. Wylde, in which the signals are transmitted by magneto-electricity. Instead of causing an armature to revolve with the wire coils, the latter are placed upon the arms of the permanent magnet, and a small revolving armature is made alternately to open and close the magnetic circuit. The advantage obtained by this arrangement is very considerable, as, by reason of the small weight of the armature, its momentum is so reduced that the plan of suddenly arresting its revolution can be adopted in lieu of the more complicated arrangements in which the armature and coils revolve continuously, and the currents are intercepted at the proper instant by other mechanical contrivances.

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CARBONIC OXIDE AND NITROGEN.

THE following letter has appeared in the *Engineer*. We leave our readers to form their own opinion of the correctness of the conclusions to which the author appears somewhat rashly to have committed himself. The question of the identity in composition of nitrogen and carbonic oxide has been on several occasions discussed in the columns of our above-named contemporary, but hitherto only upon the grounds of their resemblance in point of atomic weight and specific gravity, a coincidence which is altogether insufficient to support the hypothesis which regards the two gases as allotropic forms of the same body. That any change in CO, by which the gas may become incombustible in presence of oxygen can be effected by the action of a single voltaic couple, appears extremely improbable, but the subject will, perhaps, furnish matter for research to those who may be inclined to investigate the statement:—

"SIR,—Since the publication of my communication in *The Engineer* of the 13th inst., I got a piece of glass tube, 3in. long and ½in. diameter, filled with CO, the tube being stopped at both ends with stoppers of cork, each stopper having a copper wire through it, and the tube being made perfectly air-tight at the stoppers by means of wax. The points of the copper wires inside the tubes approached each other to about half an inch. The wires were then connected with those of a galvanic battery having two copper plates and one zinc plate, of the dimensions of 12in. by 10in., and after it had been allowed to operate on the oxide for about thirty-six hours, one of the stoppers of the tube was taken out, and a light was applied to the oxide, but the oxide did not burn.

"The same tube was again filled with CO, and stopped as before. Another tube of the same size was also filled with CO. The oxide in the former tube was again subjected to the action of the battery for about twelve hours, and one of the stoppers having been taken out, and a light applied to the oxide, it again did not burn. One of the stoppers was then taken out of the other tube—the oxide in which had not been subjected to the action of the battery—and a light having been applied to the oxide, it inflamed with the blue colour peculiar to its combustion.

"It thus appears to be demonstrated beyond all doubt that when CO is subjected to the action of electricity it ceases to be inflammable—in other words, it loses its well-known power to combine with oxygen in the proportion to form carbonic acid. It may here be remarked that this result was predicted in my former communications on the subject —the prediction being based on both electrical and chemical grounds. In the most restricted view that can possibly be taken of the matter this is a truly remarkable—a most interesting discovery; but its remarkable and interesting nature is incalculably enhanced when viewed in connection with the theory that CO and N are the same substance in different states, as proved by the sameness of their atomic number, of their combining volume and specific gravity, and by the general sameness of their action—both gases being admittedly neutral, the only difference being that N is more neutral (that is, more inert, the two words meaning the same thing) than what CO is. In opposition to this theory it was maintained that CO was inflammable while N was not. But, as predicted on general grounds, it is now proven experimentally that when CO is electrized it loses its inflammability —becoming, in this respect, equally neutral, equally inert, and altogether identical with N itself; and the objection, so striking and strong looking to the superficial observer, vanishes, and the conclusion that N and CO are identical is corroborated in the most decisive manner.

"The *rationale* of the action of electricity on CO and its results seem to be as follows:—The atoms of the carbon and the oxygen being united or compacted together more closely by such action, they adhere more tenaciously to each other; and thus they neither act upon matter external to them, nor are acted upon by such matter so easily as before. Hence the greater inertness, indifference, neutrality, or whatever other name may be given to it, evinced by CO when electrized in its action on other bodies, as compared with the action of CO when not electrized.

"As we have thus seen that CO, when electrized, becomes so inert in its chemical action as to be no longer convertible into carbonic acid—hitherto its most distinguishing characteristic—it may, with the utmost reason, be inferred, that when so electrized, a similar inertness will be found to exist with reference to its poisonous action also, the phrase 'poisonous action' being only a special name for chemical action upon the blood, when that action is followed by the death of the individual whose blood is so acted upon. But though the fatal result is most striking, there is nothing special, peculiar, or apart in the action causing it, it being neither more nor less than common chemical action. There is strong reason for believing that the poisonous action of CO springs from the same cause as its combustible action, namely, from its convertibility into carbonic acid; and, if that be the case, it follows that when CO, by its electrization, can no longer be converted into the acid, not only does its combustible power cease, as has been seen, but its poisonous power must cease also. To put the point of the cessation of its poisonous power beyond all doubt, it will be necessary that a greater quantity of CO should be electrized than I have yet had the means of doing; but I hope speedily to be able to overtake its accomplishment, as well as the accomplishment of other instructive experiments in connection with the matter. As it is, if my observation of the experiments already made, and above related, has been correct—and of this I have no doubt, nor have those kind friends who witnessed them along with myself—then, most assuredly, it would be difficult to over-estimate their importance, or to limit the view, which they open up.

"Edinburgh, 30th June, 1862. H. K."

ON NERVE FORCE.—RELATION OF NERVE FORCE TO ELECTRIC FORCE—ORIGIN OF NERVE FORCE.

BY H. F. BAXTER, ESQ.

HAVING partly considered the present question on a former occasion, I will briefly recapitulate the conclusions that were then arrived at, referring my readers to the published papers for the arguments upon which they were established.

1. The nervous tissue, like the muscular tissue, possesses an electric state.

2. This electric state is developed during, and maintained by, nutrition.

3. The electric force of the nervous tissue is not converted into current force during nerve action.

4. Whether the electric force of the tissue is converted into nerve force during nerve action was left an open question. It is this question I propose considering on the present occasion.

§ I. *On the Conversion of the Electric Force of the Nervous Tissue into Nerve Force during Nerve Action.*

Assuming my readers to be acquainted with the conditions under which the so-called nerve current is obtained in the living or recently-killed animal, viz. by placing the electrodes of a galvanometer, one in contact with the transverse section, the other in contact with the longitudinal surface of a nerve, the point for consideration is this:—Can we obtain any evidence of a sudden decrease in the nerve current during nerve action indicative of a loss in the electric state of the nerve, and which loss may give rise to the development of nerve force, —in other words, a conversion of the electric force into nerve force in accordance with the principle of Conservation of Force.

To avoid unnecessary repetition I will sum up the general results of my experiments, as my object will be, not to study the development of the nerve current, but merely the effect upon it during the excitement of the nerve.

The animal (guinea-pigs, rabbits, and frogs) having been pithed, to avoid too great motion of the limb, the leg was fastened down; the sciatic nerve was then exposed throughout its whole course, and a piece of thin glass placed beneath it. One of the electrodes of the galvanometer being pointed and coated with shellac, excepting the extreme end, was inserted into the nerve; the flat end of the other electrode was placed on the surface of the nerve, sometimes on the distal side, at other times on the spinal side of the other. The distance between the electrodes varied. As soon as the circuit was completed and the nerve current obtained and noted, the spinal extremity of the nerve was excited by a small galvanic circle, or by a single cell of Grove's battery, so as to produce violent contractions in the muscles of the lower limb. The effect upon the galvanometer needle was that of a slight oscillation; there was no sudden or marked decrease in the nerve current; and the effect, the oscillation of the needle, was evidently due to the motion produced in the nerve by the muscular contractions. Instead of exciting the spinal extremity of the nerve, the sole of the foot was irritated by a piece of glass so as to cause reflex actions; the effects were the same.

In other experiments the distal extremity of the sciatic nerve was divided, and the electrode, instead of being inserted into the nerve, was placed in contact with the divided surface, the other electrode being placed upon the external or longitudinal surface; there was not the same oscillation of the needle as before, neither was there any marked or sudden decrease; the needle gradually receded.

The nerve, and sometimes the spinal cord, was irritated by other

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means (chemical and mechanical) so as to produce contractions; but the results were the same. It need scarcely be stated that, when employing these means to excite muscular contractions, great care is requisite that the chemical reagents, or the electrodes of the battery, should not come into contact with the electrodes of the galvanometer, and that the mechanical agent should not consist of steel or iron, so as to act upon the needle of the galvanometer. In short, in all these and similar experiments where the galvanometer is employed, no steel should be about the person, such as covered metallic buttons in the sleeves of the coat, or penknives in the pockets; nor should the shade of the galvanometer be exposed to the heating effect of the sun's rays.

Before quitting this part of my subject, I may just allude to the question respecting an increase in the nerve current during nerve action; but having considered it on a former occasion, I need do no more than refer to my published paper containing an account of the experiments in which I failed to obtain any decided evidence of an increase in the nerve current during nerve action.

From the results obtained in the foregoing experiments, I can come to no other conclusions than the following:—

1. That no sudden or marked decrease in the electric condition of the nerve occurs during nerve action.
2. That the decrease which is observed arises from a disorganization of the nerve.
3. That there is no evidence of a conversion of the electric force of the issue into nerve force during nerve action.
4. That the electric state of the nerve may be considered as one of the properties of the nerve, but not its essential property. And
5. That nerve force is a higher form of force than electric force—a force *sui generis*.

Although the foregoing conclusions lead to the inference that nerve force is not so dependent upon the electric state of the tissue as to be considered as cause and effect, we must not overlook the fact that an intimate connection exists between these two forces, as manifested in the development of the force in the fish. Here, however, the connection is not so immediate as to indicate a conversion of nerve force into electric force, as there is reason to believe, from some experiments of Matteucci, that the electric force pre-exists in the organ. And with regard to the muscular tissue, the force which is evolved during muscular contraction will be found, I believe, to arise from the force pre-existing in the muscular tissue, rather than from a conversion of nerve force into electric force. It is of the utmost importance, in discussing questions respecting the "connection of forces" or "the correlation of forces," to ascertain how far the manifestation of the forces are independent of each other, before we can apply the term conversion to their explanation. A connection may be frequently shown to exist between the forces where we may feel some difficulty in applying the term conversion, and consequently the employment of the former term may, in many instances, be the most appropriate.

As the principle of "conservation of force" is now being applied to organic phenomena, it behoves us to endeavour to obtain clear views regarding the origin of the various forces that are manifested in the living organism; and although it may be safely asserted that, whatever forces are manifested in the living organism, they are greatly if not entirely dependent upon nutrition for their origin and maintenance, it nevertheless becomes necessary to examine into the mode of their production. And here I would observe, that in speaking of forces the term may be employed in a abstract or concrete sense; and although it may frequently be more convenient to employ it abstractedly, I do not consider forces as entities, but rather as properties connected with the various tissues. Now with regard to the orgin of nerve force, the following question arises, Is it generated in any particular part of the nervous system? or is it associated with the nervous matter wherever formed?

§ II. *On the Origin of Nerve Force.*

The late Dr. Todd was the first, I believe, who distinctly stated that nerve force was a polar force. He considered the nervous substance to consist of two forms—the vesicular or grey nervous matter, and the fibrous or white nervous matter. But with regard to the generation of nerve force, he compared it to the actions which take place in a galvanic battery. He says, "At the point of junction of intermingling of these two forms of nervous matter (the white and the grey or vesicular) blood is very freely supplied, and at these points there is generated constantly and unceasingly a force which in its nature resembles very closely the galvanic force or current electricity, as developed by the galvanic battery or magneto-electric machine. . . . But there are ample grounds for the opinion that, although nearly allied to electricity, it differs from, and is probably a higher relation of force than, that power."

Dr. Carpenter says, "There can be no reasonable doubt that the production of nerve force in the central organs is dependent upon the development of the peculiar cells constituting the ganglionic or vesicular substance; that either cells or cell-nuclei are the agents in the origination of nerve force at the peripheral extremities of the nerve fibres."

According to Müller, "the nervous principle is generated and regenerated in the central organs."

Professor Huxley, in a lecture delivered at the Royal Institution, alludes to the rhythmic contraction of the heart, and states, "we know that the ganglia are centres whence that excitement (nervous) originates." And Mr. Paget speaks of the ganglia of the heart as being the rhythmic centres, and at the same time refers the effects (rhythmic contractions) to rhythmic nutrition.

Without quoting other authorities, I believe the general opinion amongst anatomists and physiologists to be the following:—that the vesicular or ganglionic portion of the nervous system originates nervous force, and that it is transmitted from one part of the nervous system to another by means of the fibrous or white portion. I will not say that this is the opinion of *all* physiologists, or that I am acquainted with the views that are generally entertained upon the subject; but as far as I have been able to understand the language that has been employed, it appears to me to be implied that nerve force is generated in one part and transmitted to another. Mr. Huxley, however, after describing the connection existing between the ganglionic corpuscle and the nerve-fibres, very pertinently asks, "What are the properties of ganglionic corpuscles?" This appears to me to be the very question requiring solution. Do they *originate* nerve force which is transmitted by the nerves to other parts? or do they merely serve as the means of intercommunication with the various parts of the nervous system, the whole extent of the nervous system originating nerve force?

The evidence upon which it is generally assumed that nerve force arises in one part and is transmitted to another, rests upon the non-transmission of impressions when the continuity of the nervous trunk is interrupted either, as in our experiments, by section or removal, or by disease. Here, however, we assume the non-transmission of impressions to be identical with the non-transmission of force, and therefore it leaves the question as to the parts originating nerve force undecided. Brown-Séquard has been obliged to draw "a distinction between the property of conduction or transmission and the property of being sensitive or impressionable." He says, "The nerve fibres of the cerebral lobes are conductors, but they are not excitable, not impressionable; and so is the grey matter of the spinal cord: when it exists alone, establishing the communication between two parts of the spinal cord, after a transverse section of the whole of the white matter, it conducts, it transmits to the brain the sensitive impressions made on impressionable organs behind the section, but when irritated it does not transmit anything, because it is not impressionable." Here, then, we are obliged to suppose the same property, the same mode of conduction to be associated with two portions of the nervous system presenting such different anatomical characters.

Assuming it possible that nerve force might be generated in the ganglionic portion as suggested by Dr. Todd, it appeared probable that a difference in the nutritive actions in it, when compared with those of the white fibrous matter, might be observed—that a greater activity would be manifested, and hence produce a more powerful nerve current. To ascertain this point the following experiments were performed.

§ III. *On the Electric Condition of the Ganglionic or Vesicular Portion of the Nervous Substance.*

In order to lay open the skull easily and readily, young animals (guinea-pigs and rabbits) were used, and after being pithed the brain was exposed, a section made, and one electrode placed in contact with the divided surface, whilst the other was placed on the surface of the convolution; the effect upon the needle amounted to 3°. There was no difference in this respect whether the experiment was made on the convolutions of the cerebrum or those of the cerebellum. The greatest care, however, is required not to allow one of the electrodes to come into contact with the blood from a wounded vessel, as the effect upon the needle was then very decided, amounting to 10° or 15° or more. Here, then, in these experiments we obtained the same effects (the nerve current) as with the two surfaces of a nerve, and, what is more to the purpose, the amount is not greater than with a nerve.

It was impossible to perform similar experiments with the grey matter of the spinal cord, inasmuch as the two surfaces are divided

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sections. When, however, one electrode was placed on the longitudinal surface of the cord, and the other in contact with the divided surface, no difference was observed when the latter electrode was placed in contact with the grey matter or with the white matter of the cord; the longitudinal surface was positive to the other as with a nerve.

Similar experiments were made on the cervical ganglia of rabbits and guinea-pigs, by placing the electrodes one on the surface, and the other in contact with the divided surface; the effect upon the needle amounted to 2° or 3°.

In all these experiments I could obtain no evidence to lead to the supposition that the electric condition of the vesicular or ganglionic portion of the nervous system differed from that of the white or fibrous, or that the intensity of the nerve current was such as to lead to the conclusion that the nutritive actions were more active in the ganglionic than in the white portion.

It may be said that the foregoing experiments do not show or prove that the vesicular or ganglionic portion is not the source of nervous power, but only that nerve force is not generated like galvanic force. I grant these objections, and am willing to allow them their full force; but they prove this fact, that there is not that difference between the two portions of nervous matter to lead us to suppose that they are endowed with distinct properties.

§ IV. *Concluding Remarks.*

Let us now consider the grounds upon which it is believed that nerve force is generated in the central parts (the ganglionic) of the nervous system; the evidence will resolve itself into this: if from any cause the influence of the will be not transmitted to the limb so as to cause contractions, it is tacitly assumed that this arises from the non-transmission of nerve force to the part, and consequently that there must be some part in which this force is generated, prior to its being transmitted. I will not say that these are the views that are generally entertained; but the language usually employed implies them. The experiments of Helmholtz, in which he has calculated the time that elapses in the conveyance of an impression from one part of the nervous system to another, and the analogy that has been attempted to be drawn between a current of electricity traversing a wire in a galvanic circle, and the force which is supposed to be conducted by a nerve, have afforded some grounds for the supposition; but how could we explain reflex actions unless we supposed that the force was generated at the peripheral extremities of the nerves? Again, if nerve force be generated in any particular part of the nervous system, how is it that we are enabled to excite contractions in the muscles of a limb by stimulating the divided extremity of the nerve? We cannot suppose for a moment that the mere irritation is converted into nerve force; this would be carrying the conversion-doctrine to rather an absurd extent.

The supposition that nerve force is generated in the vesicular or ganglionic portion only of the nervous system, and then transmitted to other parts, I believe to be erroneous. That the peripheral extremities of the nerves, distal and central, are more adapted to receive impressions than the white or fibrous substance, I admit. Impressions are made at the peripheral extremities of the nerves, and then transmitted to other parts by means of the white fibrous substance, or even by the grey or ganglionic portion; but the force, nerve force, is generated or associated with the nervous tissue under whatever form it assumes.

Although I have failed in establishing to my own satisfaction the development of nerve force from electric force, still the application of the principle of conservation of force must not be lost sight of by physiologists. We have a right to ask how a force is generated, and how exerted or expended; we have no right to assume that nerve force is increased by action; action implies exhaustion. I have elsewhere stated that nerve force may be considered in a state of tension, and that it bears a stronger resemblance to magnetism than to current force. Its loss by action, nervous exhaustion, is restored by nutrition; and increased nutrition may give rise to excess of nerve force; but during health the various forces in the organized body are so admirably adjusted, that in their action and reaction upon each other no disturbance ensues; in disease, however, the disturbance may manifest itself in various forms.

There is one other observation to make before concluding. We shall err greatly if we keep limiting our inquiries to the mere study of the electric properties of the various tissues, just as we should err if we limited them to the investigation of the heat that is developed in the animal body, or the carbonic acid in the lungs, or the urea in the kidneys. The study of one is of as much importance as that of the other. All these actions are mutually dependent and answer one common purpose—the well-being of the individual.—*Phil. Mag.*

ON THE ELECTROMOTIVE FORCE OF VOLTAIC PILES.

BY M. MARIE DAVY.

HOWEVER carefully units of resistance and of current are defined, inasmuch as these units are arbitrarily chosen, it cannot be hoped that, in estimating the electromotive force of batteries, they will directly furnish the calorific value of the special work performed by the chemical actions of these batteries. It is necessary to determine the value of a constant numerical coefficient which, like the units of resistance and of current, could be easily obtained by each physicist.

The most simple of all batteries is Smee's. The only chemical action produced normally is, the solution of zinc in acid with disengagement of hydrogen. But the quantity of heat disengaged in this action has been very carefully measured by M. Favre, and fixed by him at 18,444 for ordinary zinc, and at 18,791 for amalgamated; hence I have investigated the numerical coefficient of Smee's battery.

In a preliminary research on this battery, comprising 125 determinations of its electromotive force, I obtained results varying from 16,886 to 20,604. The difference is two-tenths, while my measurements would indicate a thousandth. This research demonstrated the existence of seven disturbing causes:—

1. *Influence of the air dissolved in the acidulated water.*—The electromotive force of a Smee's battery, the acidulated water of which is aërated, decreases gradually as the battery works; it is stationary at its minimum value when the vacuum is made and the causes indicated below do not intervene.

The oxygen of the air attacks the zinc directly, a corresponding quantity of water escapes decomposition, and the negative work of the reduction of hydrogen is diminished by so much. In one of my experiments the eletromotive force of an aërated pile was 19,320, the same pile deprived of air giving 18,796. The difference, 524, corresponds, with a mean current equal to 500, to a consumption of $\frac{1}{100}$ of a milligramme of oxygen during the ten minutes that each of my experiments lasted.

This influence of the air is one of the principal causes of the variations of the constants of the pile, noted successively by MM. Fechner Ohm, Jacobi, Despretz, De la Rive, Poggendorff, and, lastly, by M. Du Moncel. The air only dissolves in limited quantity in water; its relative influence is therefore more marked when, the current being feebler, the battery consumes less. It follows that the electromotive force ought to increase with the resistance of the circuit.

2. *Influence of the sulphate dissolved.*—The laws of the conductibility of saline solutions could alone give me the key to the effects produced by the zinc-salt formed in Smee's battery. The water, acid, and sulphate are all separately conductors; each conducts and is decomposed. The water and the acid concur in producing the normal effect, because both produce hydrogen. This is not the case with the sulphate: zinc is reduced; now this reduction of zinc gives rise to a negative work equal to 53,260 instead of 34,460, the negative work of the reduction of hydrogen. The reduced zinc does not, it is true, usually appear, because as soon as an atom of the free metal touches the platinum, a local couple is produced which redissolves it, but the work thus restored does not improve the general current, which remains diminished.

The electromotive force of a Smee's element with acidulated water being 18,796, was reduced to 18,069 by the solution of five decigrammes of pure sulphate of zinc in the liquor. The difference, 727, supposes that the conductibility of acidulated water was twenty-five times as great as that of the dissolved sulphate of zinc.

The influence of the sulphate of zinc is more marked, as this salt is more abundant, and the solution is less acid, and consequently less conducting. Neglecting the influence of the air, it is to the presence of sulphate of zinc that the gradual enfeeblement of Smee's pile is due.

3. *Influence of the concentration of the acid.*—So long as the acid solution contains more than twenty-five equivalents of water for one of acid, the electromotive force remains constant; but when the proportion of acid is greater, the electromotive force is increased by the quantity of heat which would be disengaged by mixing the solution with its compliment of water in the proportion of twenty-five equivalents. When the acid is too concentrated, traces of sulphurous acid may be formed. Thus a Smee's element mounted with concentrated acid, simply diluted with its weight of water, gave 20,279, difference, 1483, while, according to M. Favre, this difference ought to be only 743.

4. *Influence of the zinc.*—Amalgamated zinc, as is known, gives stronger batteries, than non-amalgamated ones; but the force varies also notably with the state of the amalgam and the purity of the zinc. Commercial zinc amalgamated four days, and presenting a crystalline surface giving 18,796, I found only 18,510 for pure distilled zinc dissolved in pure mercury; difference, 286.

5. *Influence of the purity of the sulphuric acid.*—Ordinary commer-

cial acids contain traces of nitrogen compounds which increase the electromotive force of Smee's battery. Thus, with an ordinary acid, I obtained 18,961 instead of 18,796, as with a pure acid; difference 165.

6. *Influence of the water.*—The influence of the water is to me the most inexplicable. While with distilled water I obtain the normal number, 18,796, with unfiltered Paris water it was only 16,886; difference 1910.

7. *Influence of the temperature.*—The influence of temperature on the conductibility of saline solutions and of metals is too marked not to be shown, if not upon the electromotive force of a pile, at least on its numerical estimation. Exact results are not possible if the temperature of the circuit varies in any of its points during the course of an experiment; no comparable results are obtained if these results of the variation of conductibility, due to the changes of temperature from one experiment to another, are not corrected.

In fine, to have concordant results, I work with a Smee's battery consisting of a plate of platinized platinum immersed vertically in a mixture of sulphuric acid with eight or ten times its weight of distilled water boiled free from air. This solution is in a vertical glass tube, at the bottom of which is a liquid amalgam of pure zinc dissolved in pure mercury. A platinum wire traversing the bottom of the tube forms the negative pole of the element. The element is immersed in a large vessel full of water, which keeps its temperature constant; by this arrangement the traces of sulphate formed arrive with difficulty at the platinum: the liquids, moreover, are frequently changed. Porous vessels are a source of trouble. Instead of varying the resistances so as to cause the intensity of the current to oscillate between two constant limits, and measuring by means of the rheostat, according to Wheatstone's method, the variable resistance employed, I introduce in the circuit fixed resistances in platinum, the temperature of which is exactly known, and hence the resistance determined; and I measure the corresponding variable intensities.

I take 18,510 for the electromotive force of this pile, which regulates the value of my constant coefficient.—*Comptes Rendus*, November 4, 1861.

APPLICATION OF GALVANIC ELECTICITY TO THE TREATMENT OF DISEASES.

THE following observations on this subject occur in the *Cyclopaedia of of Practical Medicine*, from the pen of Dr. Apjohn:—

There are several diseases incident to the human frame, in which the application of galvanism by the hand of a skilful physician, may be, and indeed has been, attended with happy results. In asphyxia, for instance, whether proceeding from strangulation, drowning, narcotic poisons, the inhalation of noxious gases, or simple concussion of the cerebral system, it is has been applied with success. In all these cases, the interrupted current—that is a succession of shocks—should be resorted to; the battery should be pretty powerful, and care should be taken that the electricity be as much as possible confined to the nerves, and that it be sent along them in the direction of their ramifications. M. Groudet was the first who proposed galvanism in cases of asphyxia produced by concussion of the brain; he experimented on rabbits, which were to all appearance killed by a few violent blows inflicted on the back of the head, and succeeded in recovering them perfectly by a succession of shocks continued for half an hour from a battery of thirty couples, and transmitted between the eyes, nose, and *meatus auditorus externus* on the one hand, and different parts of the spine of the animal on the other. The same experiments have been repeated by Majendie, Apjohn, and others with perfect success, and the former states that he has recovered rabbits asphyxiated by submersion in water for more than a quarter of an hour.

In paralytic affections also, which are of a purely functional character, or which do not depend upon organic diseases of the nervous system, or pressure exercised on any part of it, the agency of the pile can be rationally resorted to by the medical practitioner. Under this head may be ranged general or local paralysis, arising from exposure to cold, palsy of the wrists from the absorption of lead, and many varities of deafness and amaurosis. In all these cases, as the nerves are to be stimulated to increased action, an interrupted current must be employed. In case of deafness, to submit the auditory nerve to galvanic action, it is sufficient to introduce a wire connected with one of the poles of battery into the affected ear, and the other wire into the opposite ear, the circuit then being rapidly broken and completed by an assistant.

In *amaurosis*, the galvanic shock may be transmitted at pleasure through the ball of the eye, so as to traverse the retina, or be confined to those twigs of the first branch of the fifth pair of nerves, which ramify on the forehead above the orbit, and upon the state of which alone Majendie has shown that gutta serena often depends. In *aphonia*, the circuit may be completed through the organs chiefly concerned in the production of the voice, by placing a shilling upon the tongue and touching it with the negative wire of a battery whose other pole is alternately brought into connexion with, and separated from, different parts of the external larynx.

The following case of a cure of an *epileptic* patient by galvanic treatment is related by Dr. Pearson (*Revue Médicale*, vol. iii. p. 333.) The cuticle having been removed by a blister from the back of the neck and inner side of one knee, those parts were covered with bits of moistened sponge, upon which slips of linen were laid, and over all, discs of silver and copper, the former metal being applied to the neck, the latter to the knee. The discs were then connected by a copper wire and enclosed in a pouch composed in chamois leather, so as to be insulated from adjacent parts. This apparatua having been applied for six months, the case was cured. It was found to continue in action for ten or twelve hours, after which it became necessary to clean the plates and renew the pledgets of sponge and linen.

Galvanism in the form of a continued current, has also been strongly recommended by Dr. Wilson Philip for the treatment of what he denominates *habitual asthma.* His method is to employ a disc of silver to the nape of the neck, and another to the epigastric region, and then press the positive wire of a galvanic trough, consisting of from 8 to 16 pairs of 4 inch plates charged with very dilute muriatic acid, against the former, and the negative wire against the latter: relief usually occurs in from five to fifteen minutes.

Another application of the galvanic pile is to the coagulating the blood within an aneurismal tumour; this is founded on the discovery of Brande, that "when the wires attached to the extremities of the trough are introduced into any animal fluid containing albumen, the latter principle separates at the positive pole in a coagulated state." A case in which a perfect cure of an aneurism of the temporal artery was effected by galvanism, is related by M. Petrequin (*Comptes Rendus*, Nov. 3, 1845). Two needles were thrust into the tumour, and the power employed was gradually augmented up to 50 pairs. At the end of 12 minutes the throbbing had entirely ceased, and the aneurism with isochronus pulsations was replaced by a solid and indurated tumour.

Galvanism has also been applied by M. Pravaz (*Revue Médicale*, December 1830), as an *escharotic* to wounds caused by the bites of rabid animals. He details several cases in which this practice was successful, in one of which the cauterization was not resorted to until 54 hours after the reception of the bite. The battery he used was of low power, consisting of only two troughs, containing between them but fifty pairs of electrometers. The eschar was easily detached on the eleventh day, and the cicatrization completed on the seventeenth.

OBITUARY NOTICE.

IT is with great regret that we have to announce the death of Mr. W. Suter, which occurred at Aden, in the early part of May.

Mr. Suter was in 1852 the assistant of Mr. Wainwright, the contractor, and assisted to construct the telegraph on the Great Northern line.

In January, 1853, he became the assistant of Mr. F. C. Webb, under whom he was engaged (for the Electric and International Telegraph Company) until July, 1857, on the construction, laying down, and repairs of the Hague and other cables, and on the construction of the land lines from the Hague to Amsterdam.

In 1857, he left the service of the Electric Telegraph Company, and was engaged on the Atlantic cable in the *Agamemnon.*

After the return of the *Agamemnon* he was for some time engaged on land lines for the Magnetic Telegraph Company; and in 1858, was again in the *Agamemnon* at the laying of the Atlantic cable, at which operation he rendered considerable service.

In 1859, he was engaged by the Mediterranean Extension Company to assist Mr. Andrews (of Malta) to repair the Cagliari or Malta cable.

From this time he appears to have been continuously in the employ of Sir C. Bright, and subsequently of Sir C. Bright and Mr. L. Clark, and accompanied the latter gentleman on the expedition to repair the Red Sea cable; and there can be little doubt that his long experience in the practice of repairing cables must have proved of the greatest value in the operations which terminated in the successful repair of the Jubal section.

There are few who have seen more active and practical service

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in submarine telegraphy, or who are more thoroughly conversant with all the details of the work than Mr. Suter was, and we have reason to know that his steady industry, quick perception, unpresuming manner, readiness to carry out instructions, and amiable disposition, won for him the esteem and confidence of those under whom he was engaged, as well as the respect of those who were placed under his orders.

ON THE PRODUCTION OF THE ELECTRIC LIGHT FOR PHOTOGRAPHIC PURPOSES.

THE following communication has been addressed to Mr. G. Wharton Simpson, the Editor of *The Photographic News* :—

SIR,—A few details relating to the conditions for producing an artificial sunlight, which may occasionaly replace the agency by which the heliograph is usually obtained, will perhaps be of interest to many of your readers in whom are combined the acquirements both of the artist and the chemist. The question—"which is the best form of battery for our use in producing the electric light?"—has doubtless often been put by the photographer, but would appear hitherto not to have received a definite and satisfactory answer. Nor is it a question that can be readily met; for the advantages and disadvantages of different battery arrangements are so various, that it is only recently that telegraphists in Europe have arrived at unanimity in the adoption of the Daniell's battery, or in some few cases that of Mariè-Davy, which is based upon the same principles, for their particular purposes. For the economic production of a constant and continuous supply of electricity, the Daniell battery, requiring but little attention for a period of many weeks or months, is possessed of great advantages. But by other arrangements, a powerful current, lasting for a comparatively short period, is far more readily obtained. Before attempting to answer the above question, I should therefore require to know whether a battery, cheap in construction and working, occuping but little space, easily charged, emptied, and taken to pieces, and maintaining during *several hours* the necessary power for the production of the electric light, would generally answer the purposes of the photographer.

The fact of this battery requiring attention in the renewal of the existing fluid every few hours, is sufficient to unfit it for use in telegraphy or in the electro-deposition of metals, but even when constructed of very moderate dimensions, it is capable of furnishing a *quantity* of electricity far greater than would be required for the transmission of telegraphic signals, and therefore appears particularly adapted for the production of the electric light, in which great quantity has to be combined with considerable force or *intensity* in the current—in cases where the light is not required uninterruptedly for a lengthened period of time.

The elements in the batterys I would propose for use by photographers are the same as those employed by Callan in his single fluid arrangement—viz: amalgamated zinc for the positive, and cast iron for the negative elements. The exciting fluid is a mixture of sulphuric acid with a solution of common salt, to which I add a small quantity of the black oxide of manganese or of the chlorate of potash, for the purpose of absorbing the hydrogen generated on the negative plate; the oxide of manganese envolving chlorine in presence of the salt and sulphuric acid, and the chlorate acting, like the chlorine, as an oxidizing agent. The mechanical arrangement of the battery in a very convenient form, has been contrived by Mr. John Cliff of Lambeth, and will be described on a future occasion.

The following brief comparison of the various forms of battery, will enable many of your readers to arrive at some conclusions respecting their adaptability, on economical grounds, for the purpose now in view. Equal surfaces are taken in each case; and it should be borne in mind that increased quantity may be obtained by augmenting these surfaces, and increased intensity by augmenting the number of cells arranged in series.

Groves's battery.—Positive element, amalgamated zinc in dilute sulphuric acid; negative element, platinum in pure nitric acid. A porous cell is necessary to separate the two exciting fluids. *Quantity* high. *Intensity* high. Duration of action moderate.

Bunsen's battery.—The same as that of Grove, with the exception of a negative element of graphite or gas carbon. Quantity and intensity the same as in Grove's arrangement.

N.B.—The employment of nitric acid is objectionable on the grounds of expense and the liberation of nitrous fumes.

Daniell's battery arranged for quantity.—Positive element, amalgamated zinc in dilute sulphuric acid; negative element, copper in sulphate of copper. A porous vessel is necessary, and requires to be occasionally renewed. *Quantity* moderate. *Intensity* moderate. Duration of action moderate as regards the continuance of the quantity effects. Very constant, *i.e.*, little or no variation in the current while the exciting fluids are maintained of normal strength, or nearly so.

Daniell's battery as arranged for line batteries in telegraphic service.—The same as the preceding, with the exception of the exciting fluid for the positive element, which may be pure water, or a solution of the sulphate of zinc. The positive element may also be used without amalgamation. Quantity very small, intensity moderate, duration of action very great. Constancy of action very great.

N.B.—Surfaces of enormous extent would be required in producing the electric light.

Double fluid cast-iron battery.—Positive element, amalgamated zinc, negative, cast-iron. Exciting fluid for zinc, dilute sulphuric acid, for iron, pure nitric acid. *Quantity* very great, *intensity* low. Duration of action comparatively small. A porous vessel is necessary to preserve the solutions separate.

N.B.—This battery was supplied by the Electric Light Company, the cost of 48 cells being, if I remember rightly, £20. Besides the original expense, the cost of working was very great, owing to the use of the nitric acid, which moreover possessed the disadvantage of liberating nitrous fumes when the battery was in action.

Single-fluid cast-iron battery as now proposed.—Positive element amalgamated zinc, negative element a plate of cast-iron. One exciting fluid. *Quantity* very great, *intensity* low.

N.B.—In the absence of the porous cells or partitions, 60 couples may be arranged in much less space than would be occupied by 48 of the preceding.

To those of your readers who may be interested in the present question, I shall be happy to afford any further details which may be required; and I hope shortly to be able to give full data as to the original cost and expense in working of the battery arrangement I suggest for the production of the electric light for photographic purposes. I may also, perhaps, at some future time, have an opportunity of showing to you the battery in action when producing the splendid arc of light between charcoal points. I am, &c.,

DESMOND G. FITZGERALD.

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

PARA.—About 600 cases of the fine description have changed hands, chiefly for export, out of the last large public sales at Liverpool, from 1s. 10d. to 1s. 11d. per lb.

Fine Java ... ... 1s. 4d. to 1s. 5d. per lb.

GUTTA PERCHA.

No alteration; remains in the same position. See last week's report.

July 10, 1862. WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	100	50 to 55	——
20	Do. B 7 per cent. till 1862 .	all	18 to 20	——
20	Do. C. " "	all	9 to 11	——
10	London & S. of Ireland Direct.	2	— —	——
Stock	Electric Telegraph . .	100	100 to 103	102½
5	London District Telegraph .	4¾	3¾ to 3¼ dis.	——
10	Mediterranean Extension Tel.	all	3 to 4	——
20	Red Sea and India Telegraph	all	19 to 20	——
1	Submarine Telegraph, scrip.	all	⅜ to ⅝	——
1	Do. registered . . .	all	⅜ to ⅝	——
10	Do. " . . .	all	4 to 6	——
2	Telegraph to India . .	1	⅝ to ⅜ dis.	——
5	United Kingdom Telegraph .	3	2 to 1 dis.	——

Telegraphic News.

ELECTRIC TELEGRAPH.

SIR J. SHELLEY said he did not see the President of the Board of Trade in his place, or he should have asked him a question with reference to

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the matter of general legislation as to electric telegraphs. The matter was one which required to be dealt with, and he trusted the right hon. gentleman would introduce some legislation to remedy existing inconveniences.

Recent Patents.

3144. F. KOHN, Southampton Terrace, Waterloo Bridge, London, "*Copying Writings, Drawings, Prints, &c.*" Dated 14th December, 1861.

THIS invention consists in passing an electric current through a great number of sheets of paper, or any other suitable material, piled one upon another, and impregnated with substances capable of producing a coloured stain on the paper at any place where the electric current passes through the same. A substance of this kind is nitrate of silver dissolved in distilled water.—Not proceeded with.

3170. W. DICEY, Waltham Abbey, Essex, "*Submarine Electric Telegraph Cables.*" Dated 18th December, 1861.

THIS invention has reference to the covering or protecting of the core, which may be either of the ordinary or of any improved construction. And the invention consists in effecting or constructing the covering by ribbons or strips of metal applied or laid upon the core in a longitudinal direction, not perfectly in line therewith, but with a small amount of uniformly spiral twist around the core, and with one edge of each ribbon or strip overlapping one edge of the next or adjoining ribbon or strip.—Not proceeded with.

3205. T. MORRIS and R. WEARE, Birmingham, and E. H. C. MONCKTON, Fineshade, Northampton, "*Submarine and other Telegraphic Communication.*" Dated 21st December, 1861.

ACCORDING to this method of operating, the electric current employed in communicating signals is obtained by the medium of an induction coil of the following novel construction:—Upon an iron core, or a bundle of iron wires, two or more layers of thick insulated copper ribbon are to be coiled; one end of this wire or ribbon is attached to one side of a voltaic battery, and the other end is connected to one side of an automaton brake of a novel construction, and the other side of this brake is attached to the other side of the battery. The improvements in this brake are of such a nature as to render it self-cleaning, whereby a more uniform action is obtained. Instead of causing a spring to come in contact with the pin, as is generally done, the patentees make the brake spring in two parts, or divide it so that the break pin passes between the slit of the spring, or between the two springs, by which means the friction keeps the surface clean, thereby making better contact between the battery and primary wire or ribbon. To this brake is attached what is termed a condenser, which is constructed as follows:—Sheets of gutta percha, india rubber, varnished paper, or other insulating materials are cut to the desired size; upon each sheet is laid a sheet of metallic foil, such as lead, tin, zinc, or a metallic alloy cut a little smaller than the sheets of insulating material, and placed alternately to extend over the insulator at one end, for the purpose of being connected together in such a maner that, if the condenser consisted of fifty plates or sheets, twenty-five of them would be connected at each end, these ends being joined to the brake as before stated. Upon the thick wire or ribbon, and carefully insulated therefrom, they coil a finer insulated copper wire, and between each layer they insert a sheet of gutta percha, india rubber, or varnished paper, and as they increase the number of layers they increase the thickness of the insulating material. The first end of this thin wire may be connected with a line wire of a telegraph, or to the earth connection, the last end of the coil to one side of an instrument which they term an interrupter, and the other side of the interrupter is to be joined to the telegraph. The interrupter they construct in the following manner:—Upon an insulated stand they erect two metal pillars having connecting screws to attach the wire from the coil, and the wire from the telegraph. Upon these pillars they arrange an adjusting screw or screws, by means of which the conducting wire is divided, and may be adjusted to any amount of separation, according to the length of the communicating wire.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

TEXTS FROM THE BLUE BOOK.—No. 3.

To the Editor of THE ELECTRICIAN.

"That Wray's Compound, an artificial composition formed by the addition of other highly insulating materials to india rubber, and the newly manufactured pure gutta percha, closely resembles india rubber in both particulars."—*Government Report*, page xxii.

SIR,—The "particulars" referred to in the text will be found in the paragraph preceding it; they are—"smallness of its inductive discharge, and perfectness of its insulation." This is pat, pleasant, passingly pleasing, and patronizing to Leonard Wray, Esq., if to no one else, and it will be agreeable to every impartial and unprejudiced person who can appreciate any effort having a tendency to advance mechanical science and skill, especially when connected with telegraphy. And who will say that this honeyed commendation is not deserved? It is gratifying, because it is rare, to see merit patted encouragingly on the shoulder, especially by a Government Committee; it would be still more gratifying if the Government would take a leaf out of their Committee's book; unfortunately, everything is done in these high latitudes upon the "friend at court" principle, by which means you, my favoured friend, although an unmitigated muff, may secure an earldom, or be appointed purveyor of pipeclay to her Majesty's forces, as the case may be; while you, poor waif of misfortune, being probably one of the premature children of destiny—a century at least before your time, may have discovered a secret that shall beneficently revolutionize society; but lacking the services of this disinterested individual, who is so benevolent with the public purse and patronage, you may walk along the gutters of life, and when you make your exit, your secret shall die with you. Well, next to being approvingly stroked on the head by the first minister, is the being subject to the same pleasing operation by a body of gentlemen, by the Premier and his partners appointed; and so Mr. Wray is most fortunate, and I rejoice thereat; nevertheless, a due regard for the true advancement of mechanical science, and the interest of the public therein involved, necessitates us to examine minutely the grounds for public favour claimed by this compound.

Necessarily I make use of Mr. Wray's evidence, as reported in the Blue Book, which, I may be allowed to say, is most agreeable reading; it evinces a candid and ingenuous disposition, sanguine of success, and elated with the prospective future; confident and conscious of the inherent virtues of his own invention, he speaks in the strain of one certain of a glorious achievement, and, as a matter of course with a degree of inflation far from objectionable; and when he relates his capabilities of satisfying the insatiable maw which he fancies is open to receive any quantity of submarine cable, it is done with the relish and gusto of an enthusiastic youth. And don't I sincerely wish his 200 horse power (2,000 would be still better,) was fully employed in preparing first-rate materials for such a purpose. The world could do very well with 10,000 or 12,000 miles more belted electricity; and by the way, it would do no discredit to our Government if they would spend a few millions upon this sort of thing as well as upon lubberly lobsters of iron-plated men-of-war, which may never be of any use, and invulnerable forts set up to challenge the world to try the metal; not that I would let the country go defenceless, but a network of submarine wires would be of more service than all these things, they would place us in instant communication with the whole world, pay their own expense, ultimately refund the capital sunk, perhaps become a source of revenue, and, if the bellicose spirit become uppermost, why, "fore-warned is fore-armed."

But to return, I have the pleasure to inform you that Mr. Wray is no monopolist; he will only be too happy to supply everyone and anyone with his material; it is not locked up in the hands of any particular company, and he "is in opposition to no one." Gently, Mr. Wray mistakes his position here, is he not the patentee, and as such evinced a very reasonable reserve? Of course, gutta percha is nowhere compared with Wray's Compound; in fact its inferiority can only be measured by degrees of infinity, and india rubber is only so-so; but this is pardonable. We should think but indifferently of Materfamilias if she did not esteem her own offspring, with all their disproportions, the finest specimens of infantile humanity.

The subject under consideration is not by any means such a complex affair as the last we had to deal with; there is no squeamishness here, we are told without the slightest hesitation what enters into the composition of this excellent material; and, indeed, the ingenious inventor was all but letting us know the exact proportion of each ingredient; but be it observed, the tendency of our competitive state of society fosters the disagreeable habit of cutting the ground from under one, of which men in these bobbish and enterprising times are not slow to take advantage. However, Mr. Wray has told us quite sufficient to enable us to judge how far the enconiums passed upon his compound are merited. The elements that enter into its constitution are stated to be "the gum elastics," "shellac, and other resinous substances," and "siliceous" and "aluminous" matter. By your leave, a word or two on these in the order in which they stand. "The gum elastics" is an exceedingly vague term, and may mean anything from india rubber down to the juice of a plum-tree. Shellac, we know, is the best of insulators, and a rather expensive commodity, but when you add "and other resinous substances," it may be made elastic enough to comprise Irish moss and cow heels, and the heels of animals that are not cows. "Siliceous" and "aluminous" matters are, to an extent, open to the same remarks; what queer minerals might be brought under this class, at a pinch, the progenitor of Caeculus only knows, and verily it is a most extraordinary ingredient; it may increase the insulating properties of the compound, but it must be at the expense of its pliability, and that flexible yet tenacious consolidation, so essentially necessary in the core of a submarine cable. Notwithstanding all the information vouchsafed to us, it would be hard to tell positively of what this compound consists. According to the specification of the patent, there would probably be one-half india rubber, a-third shellac, and a-fifth

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of powered flint or glass; and yet in the specimens particularly recommended for submarine cables, there is an admixture of gutta percha, and this would appear to be a necessary element, if the evidence of the inventor is worth anything. It is admitted that this admixture is derogatory to its insulating qualities; although even then it is "infinitely superior to gutta percha" alone. And so you see the mist gathers just here, and it is with difficulty we can see the way; but let us grope, we are used to it in pulling through the "wilderness of this world."

Like a wise man, Mr. Wray would wish to throw us off the scent, and I must admit he has been tolerably successful; after considerable pumping he reluctantly lets out that india rubber, shellac, and powdered flint are the precise materials; and yet previously the comprehensive terms "gum elastics," "resinous substances," &c., were the indefinite phrases made use of; not that we have any right to complain, it is but natural, with all his apparent candour, he should wish to keep us in the dark, but I allude to it in order to show that the atmosphere is really foggy.

The best specimens submitted by Mr. Wray are just those which would be useless comparatively for insulating submarine wires, inasmuch as the mineral ingredient in the compound deprives it of the requisite adhesive homogeneity; hence, as the evidence goes on to show, in order to render the compound suitable for the purpose in question, the gutta percha element is increased, and by that means its insulating qualities lessened; but why the gutta percha should be increased, or form an element in it at all, I cannot tell, unless it be for the sake of cheapness. In order to counteract the brittle nature of "resinous substances" intermixed with powdered flint, one would naturally think it imperative to use the toughest and most elastic gum to be found, which we know to be india rubber and not gutta percha, the latter will crack of itself under no very extraordinary circumstances, but caoutchouc never; and it is really the only thing that can be used as an insulator, which will effectually amalgamate with elements of a totally opposite character, and nullify their discerptibility. But at best, such amalgamation can only be derogatory to the gum. Suppose you decrease the inductive capacity by the intermixture (which I am disposed to doubt), your compound is inferior to the gum itself in some of its most important qualities, for the simple reason that the mineral element renders nugatory its cardinal virtues; the fact is, a mutual abnegation of their respective qualities is the result of this amalgamation—a result which characterises all compounds made up of antagonistic materials; in this case the rubber is dispossessed of a portion of its tenacious pliability, and the mineral of its brittle disjunctiveness, and the result is certainly not satisfactory. And this is all upon the favourable supposition that the right materials be used; but as before hinted at, this is eminently problematical. Suppose an extraordinary demand were to set in for this compound, what would be the consequence? Why, there are so many "gum elastics" and "resinous substances," &c., that the inventor himself would not know "Wray's Compound;" it would have undergone such a transmogrification. This is no mere assumption; every day experience affords abundant proofs. You like coffee, we will suppose, muddy if you please; you request the vendor of colonial produce to supply you with a mixture, three parts real stuff, one-fourth chicory; and what in nine cases out of ten do you get? Just the reverse, with probably the addition of a little parched sawdust. Doubtless some compounds are good, indeed I know that some are highly commended as very comforting to the internal man, but I devoutly pray the fates to comfort me on simples. French cookery is considered excellent, and I doubt not but your mouth waters at the recollection of certain dishes, but a more intimate acquaintance with the condiments thereof would hardly raise it in your estimation; for myself, I prefer not to foster my corporiety on such questionable fare, no more than I would seek the skies in an episcopalian car, illuminated with Roman candles. From this you will gather that I have a horror of compounds, and I don't mind admitting to you that such is the case; but do not attribute it to a morbidly preposterous prejudice, this would be unjust to me, weigh the matter carefully, and I think you will then agree with me that it is not unwise to avoid them.

To me it appears that the matter stands just thus: Wray's Compound is superior to gutta percha in the "perfectness of its insulation" and the "smallness of its inductive discharge," but this superiority is fully counterbalanced by its inferiority in toughness and flexibility, and the certainty of its becoming soft at a lower temperature than gutta percha does, moderate as that is. And if you compare the compound with india rubber, this inferiority is increased tenfold, while its alleged equality with that material in "perfectness of insulation" and "small inductive discharge," refers only to those specimens of Wray's Compound in which a minimum quantity of the gum elastics are used, and so rendering the material utterly unfit for the insulation of submarine cables. Caoutchouc combines every requisite of a good insulator; it is durable, pliable, capable of withstanding the highest temperature, can be rendered perfectly homogeneous without being deteriorated, and is never known to decay if properly applied to the wire; add to which, no moderate amount of straining, twisting, or bending will produce a fault; and when Wray's Compound is made to combine all these indispensable qualities, it may then share with india rubber that pre-eminence to which it is as yet unentitled.

AMICUS.

CORROSION OF THE COPPER ELEMENT IN DANIELL'S BATTERY.

To the Editor of THE ELECTRICIAN.

SIR,—In answer to your enquiry, p. 98, about the coppers which are eaten away in Daniell's battery, it is generally, but not always, the upper part of the plate. I am not sure, but I do not think it occurs at a part covered with electrotyped copper.

A high authority is of opinion that nitric acid is formed, and this idea is borne out by the discoveries in nitrification of Schönbein. He has found (*Philosophical Magazine*, June, p. 467), that nitrate of ammonia is formed when water is evaporated in contact with air; and that when pure water is mixed with pure potass, and kept evaporating in the open air, it will be found to contain nitrous acid. IGNORAMUS.

SOME experiments of peculiar interest in regard to several problems of telegraphy have been latterly performed by Mr. Burnett, at the premises of Messrs. Glass, Elliot, and Co., at East Greenwich. We hope shortly to be able to give a detailed account of the results obtained, which, if verified in practice, are stated to be susceptible of extensive application. We are glad to observe that Messrs. Glass and Elliot, as well as the Gutta Percha Company, are able to place at the disposal of those who enter into the investigation of electrical problems connected with telegraphy, the means of carrying out experiments upon an extensive scale. The first mentioned firm have more than 500 miles of insulated wire at present at their works, which we believe to be available generally to those who may have to verify any important data upon the working through submarine cables.

THE cable to be laid by the Electric Telegraph Company between Orfordness and Zandvoort in Holland, has been completed. The core was manufactured by the Gutta Percha Company, and has been covered by Messrs. Glass, Elliot, and Co. with its external protecting wires, and an outer coating of bitumen according to the patent of Sir C. Bright and Mr. Latimer Clark.

Miscellanea.

WHO has not heard of the old woman hanging her umbrella on the post to go by telegraph? or of the good old soul at Gateshead, who addressed a new pair of boots to her son in the Crimea, and hung them on the telegraph wires? The next morning she found an old pair in their place—not an unlikely thing to occur. "God bless the lad," she exclaimed, "that is good of him; I never thought he'd have sent his old ones back to be repaired!" Indeed, it is a common error to suppose that things are sent by the wires; while others are under the impression that they are pulled like bell wires. And again, we read the following:—"Mother, how do they send messages by those bits of wires without tearing them to pieces?" "They send them in a fluid state, my dear."—*Dodwell's Illustrated Hand Book to the Electric Telegraph.*

A NEW CEMENT OF VARIED USE.—New uses have been suggested for a combination of pitch and gutta percha, as to which we some years since gave instructions for the prevention of damp in walls. Professor Edmund Davy has read a paper to the Royal Dublin Society on the subject. He obtains the cement much as we suggested, by melting together in an iron vessel two parts by weight of common pitch with one part of gutta percha. It forms a homogeneous fluid, which is much more manageable for many useful purposes than gutta percha alone, and which, after being poured into cold water, may be easily wiped dry and kept for use. The cement adheres with the greatest tenacity to wood, stones, glass, porcelain, ivory, leather, parchment, paper, hair, feathers, silk, woollen, cotton, linen fabrics, &c. It is well adapted for glazing windows, and as a cement for aquariums.—*Builder.*

To Correspondents.

X.—We have not forgotten your query (p. 84). It must be borne in mind that the force of electrical attraction diminishes as the squares of the distances which separate the two bodies between which the attraction takes place. When such attraction *does* become sensible between an electrified cloud and the earth, the effects which take place are often most destructive. See the article in our present issue entitled, "Tornadoes and Waterspouts."

H. C.—A battery of several hundreds of cells would be required to charge the Leyden jar, so as to produce a spark when discharged. The jar will be *charged* with one cell; but the intensity of the accumulated electricity will only be that of the poles of the battery. By means of the condenser, the electricity communicated from a source of low intensity may be rendered evident on the electroscope. The intensity of the electricity accumulated under favourable conditions for induction is increased when these conditions are removed. You will find sufficient information on the points you mention in the series of articles entitled, "Steps to Theory," which has lately been concluded.

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The Electrician.

VOL. II. No. 37.—JULY 18, 1862.

CONTENTS:

	PAGE		PAGE
International Exhibition	121	The Outer Covering for Deep Sea Cables	127
On the period occupied in effecting the Static Charge of similar consecutive Lengths of Cable	121	Henley's Magneto-Electric Alphabetical Telegraph	129
Some Considerations on the Principles of Electrical Conduction and Accumulation	122	Electro-Silvering	130
International Exhibition.-Jury Awards for Class XIII.	124	Polytechnic Institution	132
		Prices Current of Insulating Materials	132
		Correspondence	132
		To Correspondents	132

INTERNATIONAL EXHIBITION.

WE publish this week the awards of the Jury for Class XIII in the International Exhibition. The instructions to the Jury from their Council of Chairmen were "to reward novelty of inventions, or novelty in the whole or part of the instruments exhibited, ingenuity of construction, new application of old principles, application of new principles, improvements in beauty of form, increased durability, extended applications, excellence and precision in workmanship, and economy of production." It will be seen that various orders of merit are here classed together, that "novelty of invention," and "ingenuity of construction" are in the same category as "good workmanship" and "economy of production." The grounds upon which the appliances of electro-telegraphy have been submitted to the judgment of the Jury for philosophical instruments are not, therefore, preciesly those which would have been chosen from the point of view of telegraphic progress. It is necessary that this should be borne in mind in order to reconcile several apparent anomalies in the awards. Many of those whose abstract merit stands highest, and who yet have received neither medal nor honourable mention, may console themselves with the thought that the prize they have missed is one which is awarded for the fairness of quality of linseed cake, or for the superiority of "chick peas" or preserved fruits. Still, the principle adopted in these examples out of the sphere of Class XIII scarcely explains the award of a medal to Mr. JAMES WHITE for the novelty and ingenuity of "marine galvanometer," and other apparatus, the invention of which is, we believe, due to PROFESSOR THOMSON; while the beautiful and efficient dial signalling instrument, for private use, of Mr. W. T. HENLEY, and other very perfect apparatus, remain without acknowledgment. We can only regard this as one instance of an oversight of which, unfortunately, there are several examples. There is sufficient evidence, however, that the task of the Jury, as understood by them, has, on the whole, been performed satisfactorily; and the encouragement that has so freely been awarded cannot fail to be beneficially felt throughout the civilized world.

The *Daily Telegraph* states that—

"It now appears to be more than likely that there will be some revision of the jurors' awards. The difficulty is not a slight one; for, in the first place, the value of the honour consists greatly in its being final and without appeal; while there is already a pretty general impression that medals, having been nearly as plentiful as blackberries, are not as precious as pearls, and the giving more will cheapen these distinctions yet farther. As for taking any away that have already been given, that is out of the question; so that the amendment, if any be attempted, can only amount to an imperfect patching-up of an unsatisfactory business. The discontent of exhibitors is by no means confined to those who have missed their expected award. Some are heard to protest against the loose and incorrect terms in which their articles are described; and others deem that they have been slighted by the reticence or the lukewarmness of the praise. Others, again, declare that they set no store whatever by a prize which few could manage to miss. It is a fact that in one of the classes, out of the small number of six different forms of a useful domestic apparatus, four are rewarded with medals, while the other two are honourably mentioned. The distinction here would be in getting left out. However, it seems exceedingly probable that there will be an overhauling of the decisions, and that at least some disappointed inventors and manufacturers have yet a chance of obtaining a recognition commensurate with the value they place upon their works."

ON THE PERIOD OCCUPIED IN EFFECTING THE STATIC CHARGE OF SIMILAR CONSECUTIVE LENGTHS OF CABLE.

A CORRESPONDENT somewhat reproachfully taxes us with having allowed the "great question" of inductive retardation to lapse without having ourselves afforded, or caused others to afford, any data in substitution for those we have impugned in reference to this subject. Without pretending to be able in every case to supply the desideratum of which we may point out out the necessity, we will, for the benefit of our correspondent and others of our readers interested in this problem, briefly state our own conclusions in regard to the main question affecting the comparative rate of speed normally attainable in working under ordinary conditions through different lengths of cable. The results we arrive at are sufficiently simple to admit of being readily comprehended and examined by the electrical student, to whose consideration we are glad therefore to offer them.

It may be assumed that the flow of electricity in a wire to operate a static charge takes place in accordance with the law of Ohm—that the force of a *current*, or the quantity of electricity circulating in a closed circuit, is inversely proportionate to the sum of the resistances in the battery and wire, providing the electromotive force remains constant. That is to say, if with a battery, the internal resistance of which is 20 *millivolts*, and with an external wire resistance of 20 *millivolts*, we can charge a Leyden battery in one tenth of a second to the same intensity as the pole of the battery; then, through a wire resistance of 60, our Leyden arrangement will become charged in two tenths of a second.

We recognize no essential difference between a Leyden battery and a length of cable, when the latter is to be charged through a portion of wire, the resistance of which is equal to, or greater than its own. The wire, coated with a dielectric, and surrounded with a conductor, is in fact a Leyden jar, and under the given conditions, can receive the electricity as fast as the supply takes place. It need scarcely be stated that, whether the further extremity of the wire be insulated or connected to earth, twice the quantity of electricity will be required to charge a double length of cable under the same conditions as those in which the single length is charged, providing the resistance of the battery may be regarded as infinitely small.

Let us now follow the conditions under which the charge of several consecutive portions of cable, of equal resistance, will take place. Adopting a method of analysis which is open to criticism, we will charge several portions of a cable in succession; and, by adding together the periods occupied in effecting these frictional charges, we may find the time which would be occupied in charging the whole cable by one contact.

The sign + may represent a source of electricity, one pole of which is connected to earth, and the internal resistance of which = 60, its exterior wire resistance being also = 60.

+*a* ———— *b* ———— *c* ———— *d*

Let *a b* represent a portion of wire having a considerable charging capacity, and a resistance of, say 60 units. By contact with the pole of the source it will become charged in a period of time dependent upon its charging capacity and the quantity of electricity available or furnishable from the arrangement at any moment of time. This quantity may be expressed by

$$\frac{E}{120},$$

and $a\ b$ will become charged in a period of time which we may represent as 120 units.

Now let contact be made at b between $a\ b$ and $b\ c$. The quantity of electricity available at any moment of time through the additional resistance, may in this case be expressed by

$$\frac{E}{120+60},$$

the latter number being the resistance of $a\ b$. The charge of $b\ c$ will take place in a period of time which may be expressed as 180 units.

Again, let contact be made at c between the charged wire and $c\ d$. The active force of the battery will now be reduced to

$$\frac{E}{120+60+60};$$

and $c\ d$ will become charged in 240 units of time.

$a\ c$ will, when together, become charged in 300 units of time.

$a\ d$ will be charged in 540 units of time.

Thus, if we deduct the resistance of the battery, we obtain an arithmetical ratio of increase in the time occupied in charging similar consecutive lengths of cable. If one length, therefore, becomes charged in one unit of time, a double length will, according to this view, take 3 units, a triple length 6 units of time, &c.

The resistance of the battery being negligible in practice, the normal ratio of the retardation in working through a length of cable divided into three sections, and through the same cable in one continuous length, would, according to the above considerations, be as 1 to 2.

Our conclusions must, however, be subjected to an important correction, by means of which this ratio would be considerably reduced. In charging a double or triple length of cable, although a double or triple quantity of electricity will be required, this quantity will not, under the conditions offered in practice, be equally distributed along the wire; the quantities in the successive sections being constantly less as their distance from the battery increases. This must be taken into account in calculating, according to the data we have referred to, the comparative rates of working attainable with various lengths of cable.

We have thus briefly given our view of the law which mainly governs inductive retardation. Our method of analysis may not, as we have already inferred, be accepted by all as giving with accuracy the period of time occupied in charging a cable by one contact. We are inclined, however, to maintain that it offers the closest approximation to this period, although the action which takes place when the cable is charged by one contact, is known to differ very materially from that which occurs in charging consecutively several sections of a cable.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 111].

COULOMB found that when the quantities on the two spheres were unequal, the attractive force varied still as the product of those two quantities, so that if the quantity on one remained constantly the same, the attractive force varied directly as the quantity on the other.

Thus, suppose the quantity on one sphere to be constantly one, then if the quantity on the other varied as the numbers 1, 2, 3, the attractive force would be in the three cases respectively as 1, 2, and 3.

Although this seems to be sensibly correct within certain limits, it seems that it cannot be so absolutely, for if the quantity on one ball be reduced to nothing, then the attractive force should be nothing, whereas a charged ball always exerts some influence on an uncharged one.

If the conditions of two unequally charged spheres be carefully investigated, it will be seen that the attractive force between them is due to the difference of attractive forces in various directions, and that when the quantity on one sphere only is altered, the distribution on both spheres will become altered in totally different ways, so that all the attractive forces become altered in different ratios.

If the quantity on one sphere only is constantly decreased, the distribution on it will become more and more unequal, and when a certain reduction is made in its quantity, it will be neutral on the side most distant from the other sphere; and if it be again further reduced, this same side will become in an opposite state to its previous state; when the quantity on it is *nil* it will have become polarized, having one side in an equal and opposite state to the other sphere, and the other side in a similar state to the other sphere. There exists on the sphere, therefore, in this state, two equal and opposite quantities. If these two equal quantities exerted their attractive force in exactly opposite directions, the uncharged ball would neither be attracted to or from the charged one; but whilst one of these quantities exerts all its attractive force in one direction (viz., in the direction of the charged sphere), the other quantity exerts it in various directions to the surrounding objects. The resultant of all these attractions towards the surrounding objects may therefore, if the two spheres are near to one another and far from surrounding objects, be unequal to that of the opposite quantity attracting towards the other sphere, and there may consequently exist an attractive action between the two spheres. The distribution on the charged sphere will tend to become, as the quantity on the other is constantly decreased, more and more uniform, until when the one sphere is uncharged the distribution will be nearly uniform. The problem of two unequally charged spheres, or bodies, it will be seen, therefore, is an exceedingly complex action, and is a point which requires more investigation. Sir W. S. Harris appears to have made no experiments with two insulated discs, maintained at a constant distance, and charged with *unequal* quantities of electricity; and neither Coulomb nor Sir W. S. Harris appear to have made any experiments on the attractive force between a charged conductor and an insulated uncharged one at a constant distance.

For the purpose of electrometers the laws relating to unequally charged discs or spheres, are, however, unimportant, for this means of producing attraction is rarely, if ever, resorted to.

Coulomb also performed experiments on the relation between distance and attractive force of charged conductors, and found the attractive force between two equally but oppositely charged insulated spheres to vary inversely as the square of the distance between them. Now these results do not in the least establish the relation between the attractive force of two constant and equal quantities of opposite electricity actually acting on one another at different distances.

For it is evident that as the spheres are separated, a re-distribution of the electricity on each sphere will result; the quantity maintained by direct action between them will be less, whilst the quantity attracting each towards the surrounding surfaces will be increased.

Thus if the distribution be that represented on the spheres A and B (fig. 79), then if they be placed at A′ and B′, the distribution might become the same as represented; whilst if placed at A″ and B″, close to some conducting surface, it could become so altered as to produce attraction towards the surrounding objects, and consequently apparent repulsion between the balls.

The same quantities of electricity are not therefore in action towards one another at the different distances, and consequently the experiments do not prove at all the relation between given and constant quantities of opposite electricity acting on one another at different distances; but simply that the combinations of the attractions in different directions, caused by the re-distribution in the case of two small spheres, separated different

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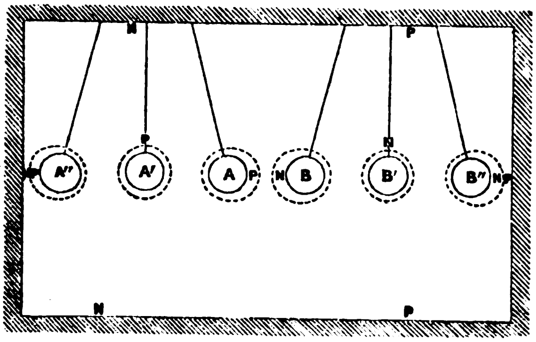
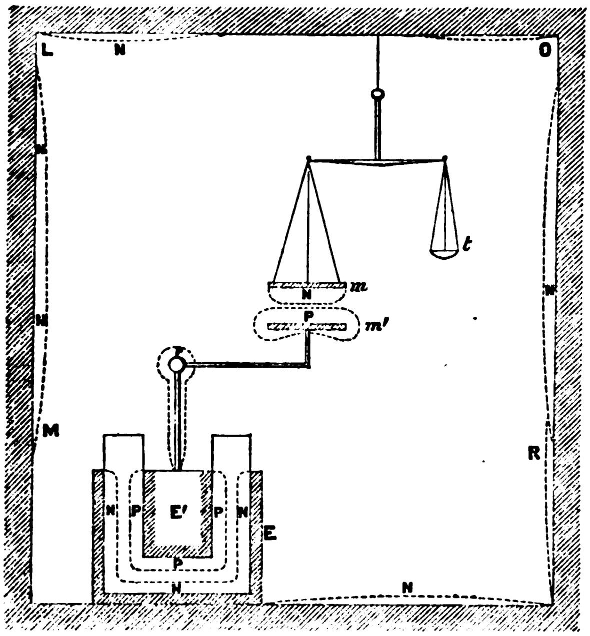
distances, within certain small limits, caused the attractive force to vary inversely as the square of the distance.

Fig. 79.



Sir W. Snow Harris has also performed experiments on the attractive force at different distances, which are still more open to objection if they are intended, as it may be presumed they are, to the investigation of the relation of distance to the attractive force of given quantities of electricity.

Fig. 76.



The experiment is described in the *Philosophical Transactions* for 1834, page 238, figure 76, being in principle a representation of the fig. 9, alluded to in the following quotation:—

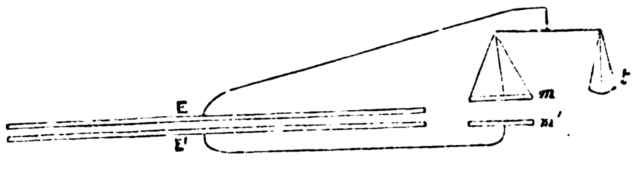
"A weight of eighteen grains being placed in the pan t, fig. 9, the parallel and even surfaces of the opposed bodies m m' were placed at 0·5 of an inch distant. A given quantity of electritity was now accumulated in the jar E, the attractive force of which just balanced the given weight, the quantity being determined by means of the unit jar. The distance between the bodies m m' being now increased to an inch, that is, to twice the former distance, and the same quantity again accumulated in the jar, the attractive force was found equivalent to 4·5 grains precisely. In like manner, a weight of two grains exactly balanced the former force, when the distance between the bodies was increased to 1·5 inch, or three times the first.

"In these experiments, the attractive forces varied as the squares of the respective distances inversely, with great precision; a law of much importance in its consequences, but which has received but comparatively little elucidation from methods of research not involving complicated conditions."

The author does not state exactly what law he deduces from this experiment; but it would seem, from the care taken to impart equal quantities to the jar E, that the experiment was made to determine "the law according to which the force of electrical attraction varies when exerted between bodies at different distances" *when charged with a given quantity of electricity.*

Now if we place the arrangement in a more analysed form as in figure 80, we shall see that since the quantity imparted to the jar was constantly the same, the space between the discs m m' being altered, the quantities on the proximate surfaces of these discs (and which quantities constituted the attractive force measured) would not remain the same.

Fig. 80



For, any quantity imparted to the interior coating of the jar represented by the plate E' would divide itself between the inner coating of the jar E' and and the disc m' in the inverse ratio to the resistance, separating the two coatings (E' and E) of the jar, to that separating the insulated and fixed disc (m') from the suspended disc (m) and all the other surrounding objects.

As the upper disc was never far from the lower disc, and as the surrounding objects may be supposed to have been distant as compared to the greatest distance between the discs, the inductive action to surrounding objects may be neglected and the total quantity would, therefore, be practically divided between the jar and the disc m in the inverse ratio to the resistances separating the coatings, to the resistance separating the discs.

Or if r = resistance between the coatings.
r' = „ between the discs.
Q = the total quantity imparted.
q = the quantity in the jar.
q' = the quantity on the discs.

Then $q' = \frac{r\,Q}{r + r'}$,

and if r' is increased m times by separating the discs m times their former distance, then

$$q' = \frac{r\,Q}{r + m\,r'}.$$

Now, the smaller r is compared to r', the nearer will

$q' = \frac{Q}{m\,r'}$, or the nearer will q' vary inversely as r' is increased. Or, in fact, the larger the Leyden arrangement the nearer will the quantity on the discs vary inversely as the distance separating them.

Thus if the inductive resistance of the jar or $r = 1$, and that between the discs, or $r' = 200$, then if a quantity $Q = 1000$, be imparted to the jar, then q' quantity on the discs $= \frac{1000 \times 1}{1 + 200} = 4{\cdot}99$,

and if r' be doubled then $q' = \frac{1000 \times 1}{1 + 400} = 2{\cdot}48$.

With a disproportion, therefore, of 1 to 200 between the two resistances at starting, the greater resistance (that between the discs), if doubled, will nearly halve the quantity on the discs.

Now the jar E, used in the experiments, is described in the paper alluded to as exposing five square feet of surface; the surface of the discs is not given, nor the thickness of the glass of the jar, so that we have not all the information for calculating the ratio of r to r' accurately.

Taking the thickness of the glass as even so much as $\frac{1}{4}$ of an inch, and the surface of the discs as equal to 6 square inches,

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then taking $\frac{1}{4}$ of an inch as an unit of length, and a square inch as unit of surface, $r=\frac{1}{720}=0\cdot0013$;

r' when the discs are placed at $\frac{1}{2}$ an inch apart $=\frac{2}{6}=0\cdot33$;

or taking $r=1$, then $r'=254$.* The disproportion between r and r' is therefore greater than as 1 to 200.

It is evident, therefore, that unless the size of the discs is considerably understated, the alteration of the distance between the discs must, in the experiment, have altered the quantity almost accurately inversely as the distance.

Now if the quantity on the discs was halved, as I have endeavoured to show it would be, when the distance was doubled, then the attractive force should be reduced to one quarter, even if the distance could have been maintained unaltered with this alteration in quantity, and as it *was* reduced to a quarter, although the distance was doubled, this seems to indicate that if equal quantities of electricity actually act on one another, their attractive force *is not altered by distance.*

This, indeed, does not seem at all an improbable supposition, and which has never yet been tested. I shall a little further on suggest an experiment which would tend to the solution of the question. But be this as it may, it is evident that in the above experiment the quantities attracting at different distances were never the same, and therefore no general law for the ratio between distance and the attractive force of a given quantity of electricity can be deduced from this experiment.

(*To be continued.*)

* The dielectric between the discs and that between the coatings of the jar being in one case *air* and in the other case *glass*, a further correction should of course be made for their different inductive capacity.

International Exhibition.

JURY AWARDS FOR CLASS XIII.

MEDALS.

UNITED KINGDOM.

Adie, P., 2846, for ingenuity and excellence of construction of sextants, telemeter, &c.

Allan, T., 2850, for the ingenuity of construction of his sparkless relay, and other telegraphic apparatus.

Babbage, — for originality of construction in his calculating machine.

Beale (Prof.), 2855, for his new mode of preparing animal tissues for microscopic observation.

Beckly, — for his registering anemometer; and for the skilful execution of his photographs of the sun.

Benhams and Froud, 2857, for excellence of manufacture of chemical apparatus in platinum.

British and Irish Magnetic Telegraph Company, 2864, for useful application of telegraphic apparatus, and originality of construction in the mercury relay and in the electro-magnetic clock (Jones').

Buckingham, J., 2867, for the excellence of his 8-inch object glass. Mr. Buckingham also exhibits one of 20 inches, but the Jury has been afforded no means of trying it.

Butters, T. E., 2871, for great excellence of workmanship of parallel glass for optical instruments.

Cassella, L. P., 2874, for his mercurial minimum thermometer and accuracy and excellence of construction of thermometers, &c.

Chance, Brothers, 2876, for improvements in dioptric lights and great excellence in optical glass.

Commissioners of Northern Lights, 2661 for the novel and excellent construction of their holophotal reflectors for lighthouses.

Cooke, T., and Son, 2880, equatorial telescopes, for his excellent object glasses and equatorial mountings.

Dallmeyer, J. H., 2888, equatorial telescopes, for his excellent object glasses and equatorial mountings.

Dancer, J. B., 2889, for the general excellence of his microscopes and microscopic photographs.

Darker, W. H., 2890, for his preparation of crystals for investigations in physical optics.

De Grave, Short, and Fanner, 2892, for balances of good workmanship.

De la Rue, W., 2893, for the general excellence of his astronomical photographs.

Elliot, Brothers, 2897, philosophical instruments, for goodness of workmanship in all objects exhibited, and for general excellence.

Glass, Elliot, and Co., 2900, for general excellence of manufacture, and successful application of their electric telegraph cables.

Griffin, J. J., 2904, for general excellence, and cheapness of the manufacture of his apparatus for chemical research.

Grubb, T., 2905, large equatorial telescope, for general excellence; with regard to his object glass no means of testing it has been afforded to the Jury.

Gutta Percha Company, 3001, for excellence of manufacture and successful application of their submarine telegraph cable.

Hicks, J., 2911, for the best Mercurial minimum thermometer exhibited.

Higley, S., 2912, for students' microscopes, combining cheapness and good workmanship, and for excellence in other optical instruments.

Holmes, F. H., 2914, electro-magnetic light, for excellence of construction.

Horne and Thornthwaite, 2916, herapathites and polarizing apparatus, for general excellence.

Kew Observatory, 2865, For excellence and accuracy of construction of instruments for observing terrestial magnetism.

Kiessler and Neu, 2922, for accuracy of construction in balances for scientific purposes.

Ladd and Oertling, 2926, for great sensibility and precision in balances for scientific purposes.

Ladd, W., 2925, for general excellence of construction of stands for microscopes, induction coils, &c.

Negretti and Zambra, 2939, meteorological instruments, for many important inventions and improvements, together with accuracy and excellence in objects exhibited.

Norman, J., 2941, microscopic objects, for excellence of manufacture.

Pastorelli, F., and Co., 2944, for good levels and general excellence of surveying instruments.

Peters, —, microscopic pantograph, for ingenuity of construction.

Pillischer, M., 2945, students' microscopes, for cheapness combined with excellence.

Powell and Lealand, 2946, for an object glass of the highest power exhibited, and for general excellence of microscopes.

Ross, T., 2952, microscopes and telescopes of large aperture, for great excellence of construction.

Sax, J., 2954, for accuracy of construction in his balances for scientific purposes.

Siemens, Halske, and Co., 2959, for the general excellence of their telegraphic apparatus.

Silver, S. W., and Co., 2960, conductors insulated with caoutchouc, for general excellence of manufacture.

Smith, Beck, and Beck, 2964, microscopes and other optical instruments, for economy in the production of students' binocular microscopes, and the excellence of their instruments generally.

Smyth, P. C., 2965, for novelty and ingenuity of construction in his rotatory ship clinometer, and rotatory apparatus to fix a telescope at sea.

Spencer, Browning, and Co., 2962, sextants, quadrants, and aneroid barometers, for general excellence and economical production.

Stanley, W. F., 2968, for excellence of construction of his mathematical instruments.

Sugg, W., 2973, photometric apparatus, for a well-constructed apparatus to determine the illuminating power of coal-gas.

Tree, J., and Co., 2976, mathematical scales, for excellence of manufacture.

Varley, C. F., 2981, telegraphic apparatus, for an apparatus to determine the locality of faults in conductors, and for improved insulators.

Wenham, F. H., 2989, for improvements in his binocular microscope.

White, James, — for the novelty and ingenuity of marine galvanometer, apparatus for observing atmospheric electricity, and static reaction governor.

Wilkins and Co., 2993, parabolic reflectors for lighthouses, for general excellence of construction.

AUSTRIA.

Kavalier, J., 653, for the great excellence of his glass apparatus for chemical purposes.

Lenoir, G. A., 656, for the general excellence of his chemical and philosophical apparatus.

State Railway Society, 666, for the novelty and ingenuity of the construction of their electric telegraph apparatus.

Voigtländer and Son, 668, for general excellence in optical instruments.

BAVARIA.

Haff and Brothers, 184, for the general excellence of their mathematical instruments.

Riefler, C., 186, for the economy and excellence of his mathematical instruments.

BELGIUM.

Gloesener, M., 349, electro-magnetic chronoscope and telegraphic apparatus for novelty and ingenuity of construction.

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Sacré, E. D., 352, for general excellence in balances for scientific purposes.

Duchy of Saxe-Cobourg Gotha.

Ausfeld, H., 2625, electric chronoscope for astronomical observations, for novelty and excellence of construction.

France.

Bardou, P. G., 1408, for the general excellence of his optical instruments.
Berlioz, A. and Co., 1146, electro-magnetic light, for novelty and simplicity of construction.
Bertaud, A. S., 1442, for the great excellence of his prisms and crystals for polarising.
Bréguet, L. C. F., 1413, philosophical instruments, for excellence in many objects exhibited.
Brunner and Son, 1415, for the general excellence and accuracy of construction of his surveying astronomical and optical instruments.
Collot, M. and A., and Bros., 1427, for the great sensibility of his large balance, and for the general excellence of his balances.
Deleuil, J. A., 1421, for his apparatus for weighing in vacuum, and for the great sensibility of his balances.
Digney, Brothers, and Co., 1414, for the general excellence, and the originality of the construction of their telegraphic apparatus.
Duboscq, L. J., 1420, optical instruments for scientific researches, for great excellence.
Dujardin, P. A. J., 1439, for the originality of the construction of his printing telegraph.
Fastré, J. T., 1392, for the great accuracy of his thermometers, &c.
Gavard, A., 1398, for the general excellence of his pantographs.
Hardy, E., 1393, chronograph, &c., for excellence and novelty of construction.
Hartnack, E. F., 1417, for the general excellence of his microscopes.
Hofman, J. G., 1440, for the excellence of his prisms and crystals for polarising.
Kœnig, R., 1394, acoustic apparatus, for the ingenuity and excellence of the construction of his instruments for phonographic records.
Lepaute, H., and Sautter, M.M., the manufacturers of lighthouses; represented by the Minister of Agriculture and Public Works, 1251, (6, 7,) dioptric apparatus for lighthouses, for excellence of construction.
Mouilleron & Vinay, 1438, for general excellence, and for the ingenuity and novelty displayed in the construction of their electro-magnetic indicator of water level.
Nachet and Son, 1416, for the general excellence of their binocular and other microscopes.
Perreaux, L. G., 1429, for the excellence of the construction of his dividing engines.
Rolland, M., 664, thermo-regulator, for novelty and ingenuity of construction.
Serrin, V., 1437, self-regulating electric light, for novelty of construction and general excellence.
Silbermann, Junior, 1397, scientific diagrams, &c., for his hemispheres for illustrating physical phenonema.
Taurines, J. M. H. A., 1430, for the novelty and ingenuity of the construction of his spring weighing machines.
Thomas, C. X., 1407, for the novelty and ingenuity of the construction of his calculating machine.

Hanover.

Landsberg and Parisius, 878, for the novelty, ingenuity, and good construction of their optometer, cathetometer, and other instruments of precision.

Hesse Cassel.

Breithaupt, F. W., and Son, 436, for the general excellence of their mathematical instruments.

Italy.

Bonelli, Cav., 1227, for originality of construction in his copying electric telegraph.
Jest, Carlo, 1232, for economical construction and good workmanship in his philosophical instruments.
Lendi, 1244, for the minuteness and delicacy of the workmanship of his microscopic medals.

Netherlands.

Society de "Altas," 187, water meters, for novelty of construction.

Portugal.

Industrial Institution of Lisboa, 834, for the general excellence of their pendulum apparatus, and level-tryer.

Prussia.

Elster, S., 1395, for the novelty and ingenuity of his apparatus for measuring the illuminating power of coal gas.
Fessel, F., 1397, myographion, for novelty and ingenuity of construction.
Greiner, F. F., 1401, for the general excellence of his glass apparatus for chemical purposes.
Luhme, J. F. and Co., 1407, for the general excellence of their chemical and philosophical apparatus.
Nobert, F. A., 1410, for the great skill displayed in the execution of his microscopic test lines.
Siemens and Halske, 1413, telegraphic printing apparatus, for their mechanical transmitter for "Morse's" telegraph, and for their voltaic induction coils, the most powerful exhibited.
Wagner, F. G., Junior, 1324, for the novelty and ingenuity of the construction of his pantograph and medal copying machine.
Warmbrumm, Guilitz, and Co., 1417, for the cheapness and general excellence of their chemical and pharmaceutical apparatus.

Rome.

Rossi, M., 23, for the novelty of his orthographic machine.

Saxony.

Ruete, T., Dr., 2331, ophthalmotrope, for novelty and ingenuity of construction.

Sweden.

Bystrom, 331, hydropyrometer, for novelty and ingenuity of construction.
Wrede (General), — for the novelty, ingenuity, and construction of his apparatus for illustrating the waves of light.

Switzerland.

Daguet, T., 152, for great excellence of manufacture of glass for optical purposes.
Hipp, M., 156, for the general excellence of his electric telegraph apparatus.
Kern, J., 158, for the general excellence of his mathematical instruments.

United States.

Darling and Schwartz, 58*c*, for the excellence and accuracy of the manufacture of their steel scales, and straight edges.

Wurtemburg.

Sauter, A., 2736, for general excellence in balances for chemical purposes.

HONOURABLE MENTION.

United Kingdom.

Ackland, W., 2845, for the accurate construction of his straight line dividing engine.
Baker, C., 2853, microscopes and other instruments, for economy combined with good workmanship.
Braham, J., 2862, spectacles, for the interest connected with his historical collection, and for the novelty of some of his contrivances.
Buss, T. O., 2870, for the accurate construction of his hydrometers.
Cameron, P., 2872, for the ingenuity and simplicity of his appliance for determining compass deviation.
Chadbrun, Brothers, 2875, for the economical manufacture of his optical instruments.
Cronmire, J. M. and H., 2885, for the good workmanship of their scales and drawing instruments.
Desvignes, 2895, mimoscope, for ingenuity of construction.
Henley, W. S., 2908, for successful manufacture of telegraph cables.
Hooper, W., 2915, Submarine telegraph cables, for novelty and ingenuity of manufacture.
Jackson and Townson, 2919, for the good workmanship of their chemical apparatus.
Johnson, H., 2920, instrument for tracing volutes, and deep sea thermometer, for novelty of construction.
Johnson, W., 2921, for the good workmanship of his spectacles with solid frames.
Levy, Professor, 2998, decimal weights, for his collection illustrating the decimal system.

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Moore, C., 2985, spherical indicator, for ingenuity of construction.
Murray and Heath, 2937, for good workmanship in his philosophical instruments.
Newton and Co., 2940, globes, for good workmanship, and for their collection illustrating the manufacture of globes.
Nicholls and Fowler, 3005, for the good workmanship of their weights and measures.
Parkes, J., and Son, 2943, for the economy of their microscopes and mathematical instruments.
Reade, Rev. J. B., 2948, for novelty of construction in his hemispherical condenser for microscopes.
Suffell, 2972, mathematical instruments, for good workmanship.
Walker, C. V., 2983, for successful application of train signals.
Webb, H., 2987, for his skilful manufacture of microscopic objects.
Wells and Hall, 2988, for their good manufacture of wire insulated with india rubber.
Wood, E. G., 2994, for good workmanship in philosophical instruments.
Yeates, A., 2995, for the good workmanship in his astronomical instruments.
Young, J., 2997, for the excellence of the manufacture of carbon elements for batteries.

India.

Cautley, Sir P., 271, Troughton's level, considered as a good specimen of native workmanship.

Austria.

Leopolder, J., 657, telegraphic apparatus, for good workmanship.
Perfler, J., 662, for good workmanship in his mathematical instruments.
Schablass, J., 663, for good workmanship in his mathematical instruments.

Belgium.

Jaspar, 350, for the novelty of his electric light regulator, and for "Navez" chronoscope.
Lippens, 351, for the good workmanship of his electric telegraph.

Brunswick.

Bornhardt, A., 285, for the good construction of his chemical balances.

Denmark.

Rasmussen, 152, induction coil machine, for novelty of construction.

France.

Balbreck, M., 1412, for the good workmanship in his surveying instruments.
Breton, Brothers, 1405, for good workmanship, and for the originality displayed in the construction of their induction coil machines, and pneumatic apparatus.
Chuard, M., 1435, gazoscope, for novelty of construction.
Colombi, C., and Son, 1395, for the good workmanship of his surveying instruments.
Digeon, R. H., 1422, for the ingenuity and accuracy of his scientific diagrams.
Dutrou, E. P., 1410, for the good workmanship of his meteorological instruments.
Lamotte-Lafluer, C. G, 1441, mathematical instruments, for good workmanship.
Lebrun, A., 1409, optical instruments, for great economy of production.
Molteni, J., 1396, for the good workmanship of his mathematical instruments.
Naudet and Co., 1391, aneroid barometers, for successful and economical manufacture.
Prud'homme, P. D., 1402, for good construction in his electric signal apparatus for domestic purposes.
Rattier and Co., 1428, for good workmanship in his submarine electric telegraph.
Sortais, T., 1447, electric telegraph apparatus, for good workmanship.

Frankfort-on-Maine.

Knewitz, P. J. F., 311, for the good construction of his chemical balances.

Hamburgh.

Kruss, A., 36, for the good workmanship of his dissolving view apparatus.
Plath, C. C., 33, for the good workmanship of his mathematical instruments.

Italy.

Bandieri, G., 1236, for novelty and ingenuity of construction in chemical balances.
Gonella, 1231, for the ingenuity and simplicity of the construction of his calculating machine.

Netherlands.

Spanje, T. Van, 186, electro-magnetic clock, for ingenuity of construction.

Prussia.

Gressler, J., and Co., 1402, galvanic apparatus, for good workmanship.
Pintus, and Co., 1411*a*, for the good workmanship of his weighing scales.

Sweden.

Klintin, J. F., 334, for the good construction of his self registering log.

Switzerland.

Amsler, Läffon, 150, for the novelty, ingenuity, and cheapness of his planimeter.
Gysi, F., 155, for the cheapness and good workmanship of his mathematical instruments.

Class IV. Section C.

MEDAL.

United Kingdom.

Cattell, Dr., 914, gutta percha, purified and decolourised, excellence of quality.
Silver, S. W., and Co., 1125, ebonite, excellence of quality.

France.

Rosseau, De Lafarge, and Co., 958, for preparations of india rubber vulcanized.

HONOURABLE MENTION.

United Kingdom.

West Ham Gutta Percha Company, 1148, gutta percha, large collection of applications.

Class VII.

MEDAL.

United Kingdom.

Siemens, Halske, and Co., 1707, for a well-constructed telegraph wire covering machine.

Class VIII.

MEDAL.

France.

Archard, A., 1023, electro-magnetic safety apparatus, ingenious and original design.

HONOURABLE MENTION.

France.

Lethuillier-Pinel, 1140, magnetic indicators of water level.

Class XV.

HONOURABLE MENTION.

Switzerland.

Müller, A., 218, electric chronograph, printing seconds and hundredth parts of seconds, speciality of production.

Class XXXI.

MEDAL.

United Kingdom.

Bolton, T., and Sons, 5995, for the excellence of his manufacture in wire and copper telegraph wire, calico printing rolls, and brass tubing.
Buist, G., 6005, for superior lightning conductors.

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THE OUTER COVERING OF DEEP SEA CABLES.

THE following valuable communication appears in the "Minutes of Evidence" given before the Submarine Telegraph Committee:—

8, Chalcot Terrace, Regent's Park,
September 25, 1860.

SIR,—In reference to my answer to the question 4659, I beg to submit a few further remarks on the subject of deep sea cable coverings, if you consider them worth printing.

So many engineers and scientific men have since the Atlantic project turned their attention to this subject, that I should not like to insist on any pattern of my own as being the very best. I beg, however, to offer a few remarks on the general question, and to offer a pattern for experiment. At the same time, I believe that the failures that have occurred have been too hastily and generally set down by the public as attributable solely to the nature of the outer covering of spirally laid iron wires.

I do not think that the failures that have occurred can be traced so much to the actual nature of the outer covering as to the proportions of the different parts, and to general mismanagement.

A good deal has been said about what are termed "light cables," and that no doubt by means of hemp, instead of iron, the mere modulus of tension of the cable in water would be increased, and this would be one advantage during the operation of laying a cable in very deep water, if it could be obtained without any corresponding disadvantages. It must be borne in mind, however, that the mere capability of a cable to support a great length of itself in water is not the only essential in an outer covering. Some amount of absolute strength with little bulk is required, besides a good protection from abrasions or mechanical violence. In laying a wire covered cable in very deep water, no doubt the narrow margin between the breaking strain, and the strain required to be applied to lay the cable, is a source of one difficulty, as it requires the necessary strain to be carefully applied.

Still there have been scarcely any failures which can be traced solely to this cause. The failure in the first attempt to lay the Atlantic cable in 1857, was evidently due to the construction of the break, which was totally different to anything used either before or since. The second year, two or three breakages took place, but these were also with a very heavy break. Still the cable was eventually laid, and evidently failed in its insulation, through causes totally unconnected with its outer covering.

There has also been, I believe, one other case of breakage during paying out on the Candia and Alexandria line, and two in picking up on the same line. But it should be borne in mind that many hundreds of miles of wire covered cables have been laid.

I think there is also a good deal of misconception as to the advantages to be gained by merely decreasing the specific gravity of a cable. Many imagine that an increase in the modulus of tension must necessarily follow. It is easy, however, to see that the specific gravity may be decreased, whilst the modulus of tension is also decreased. For if we add to a given heavy cable a substance, which, without adding any strength to the system, is heavier than water, though of less specific gravity than the rest of the rope, we actually decrease the modulus of tension, although we decrease the specific gravity of the whole system.

To take an instance, suppose a wire-covered cable be served round with hemp, giving the spiral of the hemp a very short lay. The hemp will not take its strain with the iron, and consequently can add no absolute strength to the cable. Hemp is, however, heavier than water; the cable will not therefore support so great a length of itself as it did before the hemp was added, as it has no greater strength, and yet has a greater weight per yard run. The specific gravity of the whole rope is, however, less than it was before the addition of the hemp, for as the specific gravity of the hemp is less than that of the iron-covered cable, the mean specific gravity of the two taken together must therefore be less than the iron-covered cable taken alone. Here then the modulus of tension is actually decreased by a decrease of specific gravity.

To gain, therefore, any increase in the modulus of tension, we must either increase the absolute strength without increasing, or in a greater proportion than we increase the absolute weight in water, as by using steel wires, or else we must decrease the absolute weight in water, without decreasing (or in a greater proportion than we decrease) the absolute strength, as by using hemp alone, or, supposing it were practicable, aluminium alone.

For the reasons I have pointed out, I believe that very little addition in the modulus of tension is attained by combining hemp and iron, in the pattern recommended for the Falmouth and Gibraltar cable, and now being laid from Algeria. It is said that in that cable a great increase in the modulus of tension has been attained. I cannot, however, believe that the hemp takes its breaking strain with the iron, and if it does not, it must positively, as I have pointed out, decrease the modulus of tension. My reasons for believing that the hemp does not in this pattern take its bearing with the iron are as follows:—First, a hemp strand will of itself evidently stretch more than an iron wire before it takes its breaking strain, and if the two were therefore even laid parallel they could not take their breaking strain together.

In this pattern, however, if we take each wire with its hemp serving, and consider it separately as an element of the rope, it will be seen that the hemp is laid spirally round a straight wire. Now, the soft and compressible nature of the hemp does not allow of the principles which prevent stretching in a series of solid iron wires, laid spirally round a central core, to obtain; for elongation can evidently take place by the strands compressing themselves in section closer to the iron wires, and consequently they will not, from this reason alone, take their strain with the iron. There are, therefore, two causes which lead me to believe that the hemp does not take its strain with the iron.

There are further objections in my opinion to this pattern. As the iron wires do not touch each other, but are separated by the soft hemp, the mechanical principles which render a solid iron covering so excellent as a lateral protection, and so difficult to stretch, do not obtain. The rope it appears to me would, therefore, easily stretch, and the core would therefore be exposed to greater risk than on an ordinary cable, besides which, in passing over a pulley under a heavy strain, I think the wires are more liable to cut into the core than in an ordinary cable, where from their touching each other they form a solid arch, which cannot easily have one wire crushed in.

In a good solid wire covered cable, the cable may have a strain applied very nearly equal to its breaking strain without any damage to the core; whereas in the Algerian cable pattern I believe it would be dangerous as a general rule to approach anything near its breaking strain. The advantages of a slight increase in the modulus of tension (which it is stated is attained in the Algerian cable pattern, but which I can scarcely believe), must thus be rendered useless if the limit of safe strain is reduced by the practical objections I have pointed out. The covering does not, either, offer a good protection from such dangers as knives, nails, or any such chances of injury, which should always be taken into account in designing an outer covering.

It must be borne in mind, however, that a decrease in specific gravity, if it be accomplished without a decrease in the modulus of tension, is a benefit as long as the actual process of paying out is taking place. For the terminal velocity of the cable in water will be decreased, and consequently, if we take two cables of the same absolute strength, but of different specific gravity, that which has the lowest specific gravity can be laid, with a given amount of slack, with least strain.

Thus, if we were to take two similar iron covered cables, and lay on to one a substance which, without adding strength to the rope, was of exactly the same specific gravity as water, then the following effect would take place:—The two cables would still have the same absolute strength and the same absolute weight in water, and consequently would support the same length of themselves in water. The modulus of tension would therefore be the same. But as the specific gravity of one would be reduced, and consequently its terminal velocity, it could be paid out with any given amount of slack, however small, with less strain than the cable of greater specific gravity; although to lay both absolutely without slack the same strain would be required, viz., the strain necessary to support a piece of either cable in water of the depth of the sea.

Again, if the specific gravity be reduced by adding a substance which, without adding strength, is heavier than water, though lighter than the rest of the rope, we get the following effect:—The cable of lesser specific gravity will have the greatest absolute weight in water, and as the absolute strength of both remains the same, the cable with the lesser specific gravity will be able to support the least of itself in water. The cable of lesser specific gravity will, in fact, have, as I have before shown, the lesser modulus of tension.

But as the terminal velocity of the cable of lesser specific gravity is reduced, there will be *some* amount of slack with which, if the two cables be laid, that of the lesser specific gravity will be subjected to the least strain, although to lay both absolutely without slack, that with the smallest modulus of tension will require the greatest strain.

In a combination of hemp and iron, therefore (where there must be a reduction in specific gravity over the iron alone), even if there is no

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increase in the modulus of tension, or even a positive decrease, there will be some amount of slack with which the cable can be paid out with a less strain than without the hemp. This benefit may be obtained in the Algerian cable, but it is a question whether, if there is no increase in the modulus of tension, this advantage is not counterbalanced by the other practical disadvantages.

The benefits I have pointed out as resulting solely from decrease in specific gravity, only exist as long as the cable is being paid out. When the ship is stopped, or the cable being wound back, or picked up, the proportionate safety depends, firstly, on the modulus of tension; and, secondly, on the absolute strength of the cable.

When the ships and cable are quite motionless, and the cable hanging up and down, of course the proportionate safety depends solely on the modulus of tension, and not on the absolute strength; that is to say, a cable that would bear, say 5,000 fathoms of its own length, would be just as safe as another cable, which, though of double the absolute strength, would also only bear 5,000 fathoms of its length.

When, however, we begin to operate on the cable in any way, as by winding in with a sea on, then the absolute strength comes into play. Strains are put on the cable, as by a sudden lift of the ship, or by a jerk or surge on the drum, or by the ship drifting and bringing a horizontal strain into action, which are not caused merely by the weight of the cable; and in such cases the safety of the cable depends on its absolute strength.

This will be more easily allowed if we consider the case first in shoal water, say 200 fathoms. Here the weight of the cable is still the sole element of strain when the ship and cable are motionless, and the safety of the cable depends on the *proportion* this strain bears to the breaking strain, quite independent of the absolute value of that breaking strain. In fact, the safety of the cable depends on its modulus of tension, the same as in deep water.

Thus, if a cable like the Atlantic would be subjected to a strain of 3 cwt., its breaking strain being 4 tons, and ten of these formed into a compound cable, would be subjected to a strain of 30 cwt., and stand a strain of 40 tons. Therefore, although the modulus of tension would be the same for both, the surplus strength or margin of strength would be ten times greater in one case than the other.

It would be absurd to suppose that, considering all the contingencies and varying strains to which a cable is subjected, particularly in foul weather, that this compound cable (possessiug ten times the margin of strength of the single cable) could not be handled and laid with the least danger of the two. It is therefore evident that absolute strength is a practical advantage, and if so in the case we have supposed, it would be so in still deeper water, and it is a question at what depth this absolute strength shall be neglected as useless. In considering this, it must be borne in mind that the operation of laying long lengths of telegraph is not limited to the sole operation of steadily paying out.

It has not unfrequently occurred that faults of insulation have only been detected a few minutes after they have left the ship, and that winding back, or, as it is termed, "picking up," has been necessary, and in such case the absolute strength would come into serious requisition. This has occurred both with light and heavy cables. Absolute strength would appear therefore to be an advantage even in deep water.

In considering the specific gravity of a cable, it must be borne in mind that there are practical objections to a very low specific gravity; for, if very low, the cable cannot be laid with sufficient slack to meet the necessities of the irregularities of the ground where there is rough ground, and would thus be suspended from point to point. During the act of submergence such an enormous length of cable would also (with a very light cable) be suspended in the water in a straight line without any slack, that a portion of its centre might be acted on by a stratum of current, whilst a larger portion at each end of such length might be in still water, or in water moving in a contrary direction, and thus a great strain would be brought on the cable at every point in that portion of the cable which remained in the current, and for a considerable distance on each side of the points of contrary flexure. As the current continued to act and sweep the bight away, taking up whatever slack existed, the strain would be increased until the cable might be damaged or broken, before it could sink through into the still water below. This may be a remote contingency, but still it should not be neglected in considering the case from every point of view.

In such a case, with two cables of given strength and bulk, that which had the greatest specific gravity would here stand the best chance, as it would sink faster through the current, and thus not give time for the current to take up the amount of slack with which it would be paid out. With cables of the same specific gravity and bulk, that which had the greatest absolute strength would stand the best chance.

A great deal has been said about the stretching of an iron wire-covered cable, caused by the spiral lay, but this is greatly exaggerated, and it is evident that those who insist on this as a necessary theoretical consequence do not see the mechanical properties of the case.

For any elongation to take place each spiral wire must be straightened to some extent, that is, it must approach nearer to a straight line. Now this can only arise, taking a single wire, either by its retaining its regular number of convolutions, and by its being flattened in that position, or by the rope actually untwisting. The first of these effects can only take place by each wire approaching to the centre of rope, and thus occupying a smaller circle; but as the wires are already in contact, they can only assume this new position by crushing each other laterally. They, in fact, form an arch, which, if hollow, would be in unstable equilibrium, and liable to be disturbed by any lateral pressure on one wire, but the core, without receiving any great pressure, acts as a kind of centreing, keeping the whole system in shape by preventing any one wire getting out of position, by being forced inwards; whilst the tension on each wire prevents it from getting out of position, by being forced outwards. Thus, as long as the wires are thus kept in their circular position, no elongation can take place, and no crush can come on the core. Any slight elongation that takes place is simply due to the wires being scarcely in solid contact in every part of the rope, and thus, until they take their bearing, and are in contact throughout, there will be a slight degree of elongation. This elongation is not, therefore, a necessary consequence of the theoretical conditions of the case, but is simply the result of the impossibility of absolute perfection in manufacture, and depends, therefore, on the degree of perfection with which the rope is manufactured, and I believe in a well made cable will not exceed a half per cent. before the cable breaks.

It is true with a cable covered with strands, like the Atlantic, the strands do not form such a solid and stable arch as the solid wires, and, consequently, much more elongation will take place, and I think this is undoubtedly a disadvantage in a strand-covered cable.

As I have before said, the Algerian pattern cable must also, from the wires not being solid contact, be liable to a greater per-centage of elongation.

In a covering of solid wires, also, it is evident that the greater the number of wires the more unstable must be the system.

The second effect, viz., untwisting, can occur in two ways; first, in the case of one end of the cable being free to revolve, which is not, however, the case in paying out a cable. Secondly, by one part of the rope untwisting, thus twisting up another part tighter. Now, in paying out a cable in very deep water, the upper part of the cable which is in suspension from the ship to the ground, is under great tension, whilst that portion which is near and at the bottom is always slack, since the cable is always paid out with a certain per centage of waste cable.

The weight of the suspended cable will attempt, therefore, to untwist the upper portion, and twist up the lower portions; and as the lower portions are not only slack, but have been already untwisted at the top, they offer no great opposition to this action, which can, therefore, take place in very deep water to some extent, although as each portion of the cable goes through exactly an equal amount of twisting and untwisting, it is in exactly the same state when laid as it was before it left the ship. This action undoubtedly took place to some extent in the Atlantic cable, where it is stated that pieces of paper attached to the cable made several revolutions between the stern-wheel and the water. In a solid wire covering there is, however, another force which tends to prevent this untwisting. The wires being laid on by the patent wire process, are only bent into the spiral position, and are thus free from all torsion in their fibre.

To untwist, therefore, it will be seen (if the experiment be tried), that torsion must take place in each wire, and as with a long spiral it requires an immense tension to produce untwisting at all, the joint resistance to torsion of all the wires together is sufficient to prevent it entirely. Indeed, I have watched very carefully to see if untwisting took place, both in paying out the Corfu and Malta lines through 1,900 fathoms, and in picking up the heavy cables in the Mediterranean, and I never could detect a trace of such action.

In the strand-covered cable, for untwisting to take place each strand must itself be twisted up tighter. This force replaces the resistance to torsion of the solid wires. It seems evident that the resistance of these strands to be twisted tighter is not so effective in preventing the untwisting of the cable as the resistance to torsion of the solid iron wires, since the action of untwisting takes place more in the strand than the solid wire rope.

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The question of the coiling and uncoiling of a cable, and the effect upon such cable, appears to me from various statements to be little understood. Some imagine the rope has actually a series of permanent twists or turns put into it by the process of coiling and uncoiling. This is not the case. When a rope is coiled, the rope is twisted once round on its axis, for each convolution of the coil, and is thus in an over-twisted or under-twisted state (according to the way it is coiled), as long as it lays thus coiled. But the act of uncoiling puts a reverse turn or twist into the rope for every convolution, and thus the turn put in, in coiling, is neutralized, and the rope is in the same state as before coiling.

It is true that, by bad coiling, the twist requisite for each convolution may be put into the cable all at one place in the convolution of the coil. In the act of uncoiling, although a turn in in the reverse direction must of necessity occur for each turn put in coiling, yet this again, from the manipulation, may be put in at an opposite part of the convolution to that where the turn was put in in coiling. The two turns will thus exist for a moment in the rope, though they are in reverse direction, but the moment any strain comes on the rope, they will instantly neutralize each other, and the rope will be exactly as it was before coiling.

If the rope be coiled in a perfectly circular coil, and the leading part led down over the centre of the coil, this effect even cannot occur, for in coiling, the turn will be equally destributed over every part of the convolution, and in uncoiling the same, and thus the only effect of coiling is to cause the rope whilst it is laying in the coils to be in a state of slight torsion, which is immediately annulled on its leaving the coil. The amount of torsion depends on the size of the coils in proportion to the size of the rope, and it is, of course, greater on the inner convolutions of the coil than on the outer. It is dangerous to make the inner diameter of a coil very small, for there is evidently a limit to the flexibility of every rope. These effects would apply to any rope, whether platted, spiral, or straight. They are the essential conditions on which alone the coiling of a rope can take place.

I may also remark that coiling and winding are two different processes. When a rope is wound on a drum, there is no turn put in, and in unwinding there is also no turn put in. If a rope is *wound*, therefore, and then *uncoiled*, one permenant turn or twist will exist in the rope for every convolution, and such a process should never, therefore, be adopted. In the same way, if a rope be coiled and then the coil be lifted bodily on to drum, and unwound, one permanent turn for every convolution of the coil will be put into the rope.

In the manufacture of short lengths of hemp or iron rope, they are wound on to drums as they proceed from the machines, and then slipped bodily off the drums for sale. If one of these were then placed on a drum and unwound, the rope, when laid out straight, would be free from all torsion, and would be exactly in the state in which it was manufactured.

These generally fall, however, into the hands of sailors and others who invariably uncoil them. Now, if they take the outer end of such a coil and uncoil, they would put a turn into the rope for every convolution, and according as the rope was wound, and the actual lay of the rope, this would either twist the rope up tighter, or else unlay it to a certain degree. By passing this end through the coil they would reverse the action. Now, as the rope will, according to the nature of its manufacture, bear either being laid up tighter rather than be unlaid, or *vice versâ*, directions for passing the end through or not, are sometimes attached to the coils, and if they are not, the men soon find by practice which process brings the rope out into the most flexible state.

This necessity in the uncoiling of new ropes has led some naval officers to imagine that a submarine cable (which is never wound on a drum, but always coiled,) must leave the ship in a state of torsion. I trust, however, I have explained that this is simply a misconception on their part.

It appears to me that the following are the necessary requisites in a deep sea cable covering:—

1. That the covering of itself be unlikely to injure the core in any way when subjected to strain, or to allow any injurious strains to come on the core until it is itself destroyed.
2. That it shall be a good production to the core against any lateral pressure or strain.
3. That it shall have as high a modulus of tension as possible.
4. A moderately low specific gravity.
5. As great absolute strength as possible in proportion to its—
6. Bulk, which should be as small as possible.
7. Cheapness.
8. Facility of manufacture, with the least possible danger to the core.

Lastly, that it shall be as durable as possible in water, whilst it will allow water to reach, at once, the core, even under low pressure, so that the core may be easily electrically tested for insulation.

The first two conditions appear to me to be met by a solid wire-covering better than by any other covering I have yet seen.

With regard to the third, hemp has the advantage over iron, but I doubt weather it has any advantage over steel.

For the fourth condition, it is possible iron or steel may be combined with advantage with hemp, but I think not in the way the Algerian cable is made, without other disadvantages which I have already pointed out.

The fifth condition, and sixth, would be best met by steel, for it is evident that the same strength as steel cannot be obtained by iron without greater bulk, and with hemp without a very great increase in bulk.

The seventh condition, no doubt, steel would stand last, and hemp first.

The eighth, I think, has not been sufficiently considered; and I think that many of the coverings I have seen would be exceedingly difficult and tedious to manufacture.

The last condition is one of the most difficult to fulfil. Many of the proposed protections to an iron or steel covering, would be of themselves nearly water-tight, and would thus prevent the core being tested for insulation under low pressure.

I would suggest the following pattern as a good cable for experiments;—

1. Outside the core a serving of strong and well made strands of of hemp but made with a very long lay, much longer than the ordinary serving which has generally been made so as to add no strength to the rope.

Secondly, a layer of solid galvanized iron wires, laid on in a shorter lay than the hemp serving, and in the reverse direction.

Thirdly, a layer of strong strands of hemp, laid in the same direction, and with the same length of lay as the first hemp serving.

I think such a cable would possess the following advantages:—

1. By adjusting the proportion between the lay of the iron and the hemp, the two might be made to take their breaking strain together; the absolute strength would be thus increased, by the hemp, in a greater proportion than the weight in water is increased, and consequently, there would be an increase in the modulus of tension over a simple wire-covered cable; and there would, conseqently, be increased safety when the cable was hanging perpendicularly from the vessel, or when being laid without slack. The specific gravity would be also decreased by the addition of the hemp over a wire-covered cable, whilst, as I have shown, a positive increase in the modulus of tension would be obtained; consequently, with a given amount of slack, the cable could be laid with *much* less strain than a wire-covered cable of the same absolute strength. From the presence of iron in the system it is evident that a greater absolute strength with a given bulk, can be obtained than with a simple hemp cable. The proper specific gravity for sinking conveniently, can be adjusted by the proportion of the iron to the hemp. The cable would also be even safer as regards mechanical protection to the core, than a simple iron-covered cable. The second coating of hemp would tend greatly to protect the iron from oxidation, whilst it would not prevent the water from penetrating the core for testing the insulation. The servings being both in opposite directions to the wire covering, would completely counteract any slight tendency to untwist, which a heavy strain may have in extremely deep water. Such a rope could be easily manufactured, and at a cost little greater than the ordinary cable. Of course, steel instead of iron would render the pattern still more adapted for the work, and for any important line in deep water, I believe the increased safety gained by steel would compensate for the extra expenses.

I would remark that all the practical objections which, in my opinion, exist in the Algerian pattern, are here met, and I believe that it meets many of the objections to a simple hemp or simple iron covering. Still I would only submit the pattern as one for discussion and experiment.—I have, &c.

(Signed) F. C. Webb.

To Captain Douglas Galton, R. E.,
Chairman of Committee on Submarine Telegraphs.

HENLEY'S MAGNETO-ELECTRIC ALPHABETICAL TELEGRAPH.

This very simple and efficient instrument is now coming much into use with private firms having branch establishments; also with colliery owners, and with mill proprietors in Manchester and other

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large towns in the manufacturing districts, as a means of communication between their mills and warehouses. It is, also, exceedingly well adapted for railway purposes; any person that can read can use it without any previous knowledge of telegraphy. It requires no battery, and has no complicated machinery liable to get out of order. The only attention required is the application of a little oil once a month to the bearings. Gentlemen engaged in business can communicate with their partners who may live at a distance, or confidential clerks at their houses of business with the greatest facility without the necessity of imparting their secrets to a general telegraph clerk.

Fig. 1.

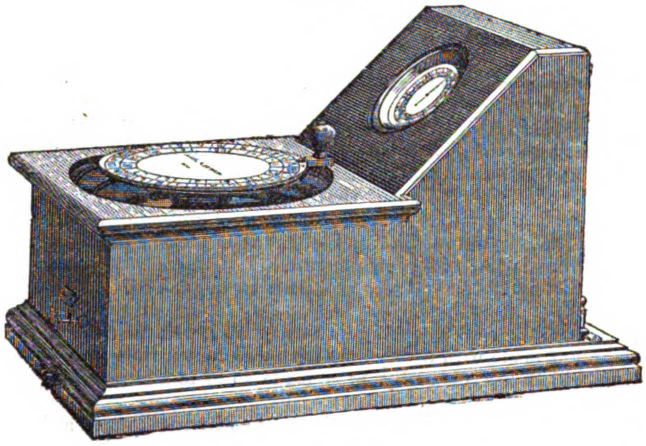
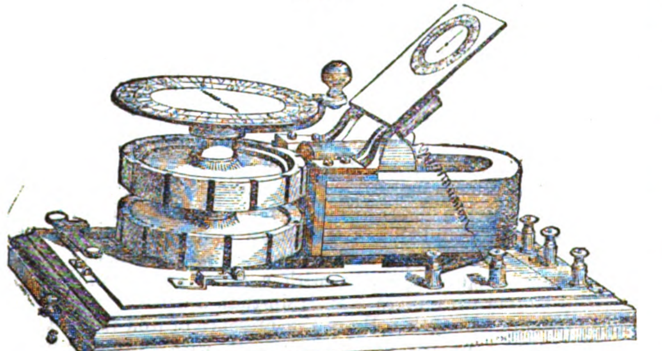


Fig. 2.



The instrument is represented in fig. 1, with case complete, and in fig. 2 with the case removed. The apparatus consists of two parts; that in which the current is induced, and by which it is transmitted, and that for receiving and indicating the signals. The first part is in the form of a horseshoe permanent magnet, with a temporary magnet, or armature, surrounded with coils of insulated wire placed within its poles, and a double wheel of brass revolving on a fixed axis. These wheels have on the periphery twenty-six pieces of iron, thirteen on each wheel. They are formed by turning a ring of soft iron to fit each wheel, attaching it firmly by twenty-six screws, and dividing it into thirteen pieces by the wheel-cutting engine. These pieces, as they pass the ends of the permanent and temporary magnets, make a connection between the poles of each in such a manner, as to reverse the polarity of the latter completely at the passing of each piece, and consequently inducing currents of electricity alternately in opposite directions.

The receiving part consists of a dial with the letters of the alphabet in a circle, with revolving index or pointer, and a toothed wheel of a peculiar construction. This wheel is propelled, step by step, by the action of a magnetic needle, or bar, the upper end of which is formed into a pair of palletts, which act on the inclined teeth of the wheel, and the lower end oscillates in a slot formed in two pieces of iron fixed on the poles of a small electro-magnet, through the coils of which the current received from the distant station passes.

In the transmitting apparatus a dial is fixed on which the double wheel revolves. This has letters and figures corresponding to the receiving dial. The wheels are revolved by a handle with a knob and pointer moving round the edge of the stationary dial, and as one revolution of the wheels causes twenty-six currents of electricity to be transmitted, these will cause the wheel index on the receiving dial to make one revolution also. It therefore follows that the two will keep time together, and whatever letter the pointer attached is made to stop at, will be indicated on the receiving dial. The springs seen on the base in fig, 2 are for making a short circuit when receiving, so that the current may not have the resistance of the sending coils to overcome; the other is for putting the hand right on the receiving dial if it should go wrong. As these instruments have only one moving piece of machinery, without any multiplying power, cranks, cones, or other complications, and have no break pieces or current reversers (the circuit always remaining unbroken), they cannot get out of order, and the magnetism will remain the same for many years.

The instrument above described can now be seen at the International Exhibition (Class 13), and we recommend the inspection of it to our readers, as it embodies several important practical improvements in apparatus intended for commercial and domestic telegraphy.

Mr. Henley also exhibits an exceedingly well-constructed galvanometer, for testing insulated wires—the property, we believe, of Messrs. Wells and Hall, and a very ingenious application of electricity for horological purposes, as well as samples of various submarine cables successfully submerged by him during the last few years.

As an act of justice towards Mr. Henley, we feel it our duty here to state that the instruments constructed by him during the late Government investigation were employed by the Committee with the most satisfactory results.

ELECTRO-SILVERING.

The old mode of silver-plating, which is still practised at Sheffield to some extent, consists in taking a piece of silver of nearly the standard of purity used for coining, soldering this upon a bar of copper, and subjecting the metals thus united to the dilating process of heavy rollers. By this process, as the two metals extend equally, the silver is reduced to an exceedingly thin covering. The plated metal is then manufactured into the required shape, and different parts are soldered together. The handles, edges, and ornaments of vessels, or other objects, are made of thin silver rolled to about a square foot to the ounce, and then struck in a die, and the hollow parts filled up with an alloy of lead and tin. The dies used in these operations at some manufactories are stated to have cost many thousand pounds. This alone is a serious objection to the old method; but its principal drawback consists in the fact, that the articles can only be plated by this process *before* being manufactured into the required form, and an article so plated, when worn through in any part, was valueless before the introduction of the electro-process. There are other objections to the old method, but the heavy restrictions on taste and design which it imposes, compared with the entire freedom and facility of merely depositing the silver by electrical agency on articles already manufactured, and of any suitable metal, constitute a disadvantage so obvious that it cannot be expected to compete successfully with the new process.

It was some time before the electrotype was applied to the deposition of any metal but copper. The first practical method of depositing the noble metals with a satisfactory result was patented by the Messrs. Elkington. The solutions they employ are the argento-cyanide and auro-cyanide of potassium—the former to deposit silver, and the latter for gold.

The argento-cyanide, or silvering solution, consists of cyanide of silver dissolved in cyanide of potassium. This solution may be prepared in various ways, but it will be sufficient to indicate the two most eligible processes. One of these is performed by simple chemical mixture, and the other with the aid of a battery.

To prepare the solution by the chemical method, metallic silver is dissolved in four parts of nitric acid, diluted with one part of water; the diluted acid is heated in a vessel, and the silver added by degrees until all dissolved. A solution of nitrate of silver—lunar caustic—is thus formed, which is transferred to a large vessel, and further diluted with ten parts water. Dissolved cyanide of potassium is then added so long as a white precipitate falls. This precipitate is cyanide of silver. When it has sufficiently settled down, the clear liquor is carefully decanted, and after the precipitate has been well washed to remove the soluble salts, a solution of cyanide of potassium is added to it until it is completely dissolved. The resulting liquid constitutes the cyanide of potassium and silver, and forms the silvering menstruum, which should be diluted to such an extent as to contain one ounce of silver in the gallon. The salts of potassa *in strong solution* exercise a slightly solvent action on cyanide of silver, and it is to prevent a loss from this source that the nitrate of silver is diluted previous to adding the cyanide in the first instance.

But the best and most economical method of preparing the silver solution, and that which is generally employed in electro-metallurgical factories, is by the use of the battery. To make a depositing liquid containing one ounce of silver to the gallon by this process, make a solution of cyanide of potassium of the strength of one-and-a-quarter ounce to the gallon of water employed; then place a porous vessel in this mixture, so as to stand with its mouth at least one inch above the surface; fill this vessel with the same liquid to the level of the liquid in the outside vessel; put into the porous cell a sheet of copper or iron, and connect it with the

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zinc terminal of a battery; in the bath, or large solution, put a sheet of silver, and connect this with the copper terminal. By the aid of a Wollaston's battery, consisting of four pair of plates, the zinc ones being about six inches square, the required quantity of silver will be dissolved in the bath in the course of a few hours, forming the cyanide of potassium and silver, which is now ready for use. By weighing the sheet of silver before and after the operation, the quantity that has been dissolved will be ascertained.

From this solution, prepared by either of these processes, silver may be deposited upon any metal; but copper, brass, and German silver, are the best for plating upon. Lead is by no means difficult to plate, but the two metals have generally a weak adhesion, because the lead, although made perfectly clean, becomes in part coated with an insoluble cyanide as soon as immersed in the solution. From its softness, also, it readily yields to the pressure of the burnisher. Tin, zinc, iron, pewter, and Britannia metal are not so easily coated with silver as lead; but all are occasionally plated by the electro process, though the metal now most generally used for all new work is German silver.

Whatever be the nature of the metals to be plated, the articles intended for this purpose must not be immersed in the silver solution until they have been carefully prepared to receive the deposit. In plating and gilding, a principal object is to render the deposited metal as fixed and permanent as possible; but if the surface of the article has not been properly prepared, the deposit will rise up in blisters, which a touch of the burnisher will rub off, and the whole operation will be useless. The careful preparation of the articles is, therefore, a point of vital importance.

This may be performed by the wet or the dry method. M. Becquerel prefers the latter, which, however, can only be applied when the work of the article is not of a delicate character. The object of the operation in both cases is to remove from the surface intended to receive the deposit every particle of grease and oxide, which, if present in the smallest quantity, tend to diminish the adhesion. The dry process simply consists in scouring the articles with sand, glass, or emery paper, or with very fine pumice-stone powder, using for this purpose clean brushes perfectly free from grease, or bundles of fine brass wire, technically called scratch-brushes. Particular care must be taken to avoid comtact with the moisture of the hand, which both oxydizes and greases the surface. The alleged advantage of the dry over the humid process is, that in the latter case, an interval, however short, must always occur between the act of removing the article from its last liquid bath, and placing it in the solution of the metal to be deposited; and during even that momentary interval the article, or some part of it, is liable to acquire a film of oxide.

From the nature of the articles subjected to the process, the number of cases in which the dry method is available is, however, very limited. The other method is, therefore, generally practised in factories, and by the exercise of due care the adhesion may be rendered by this process quite perfect. It consists in alternately subjecting the articles to alkaline and acid solutions, the former to free them from grease, and the latter from oxide; brushing or rubbing with fine sand, and rinsing in pure water. The article is first boiled in a lie of caustic potassa or soda, containing about half a pound of the alkali to the gallon of water, and then dipped into nitric acid, diluted to such an extent as merely to act upon the metal. It is then scoured with a hard brush and sand, of which a very fine description obtained from the Isle of Wight is the best; after which it is washed thoroughly, and dried, and then weighed. A copper wire is now attached to it, either by twisting it round the article or putting it through any open part. It is then dipped into nitric acid, containing ten per cent. of sulphuric acid, or into a mixture technically termed *pickle*, and composed as follows:—

Sulphuric acid	64 parts.
Water	64 „
Nitric acid...	32 „
Hydrochloric acid...	1 „

It is quickly removed from this bath, washed by immersion in distilled water, and then, without loss of a moment, dipped in a solution of nitrate of mercury till the surface is white. From this the article is taken out and *struck* in the silver solution; that is to say, it is suspended by the wire connected with the zinc of the battery, when it is immediately coated with a thin film of silver. This operation is termed *striking*, and batteries of intensity are used for this purpose. After a few seconds, it is taken out and well brushed. On the large scale, brushes of brass wire attached to a lathe are employed, but for small operations a little fine sand rubbed with a hard hair brush will effect the object, which is to remove any particles of foreign matter that may still adhere to the surface, and to test the completeness of the coating. The article is then washed in water, and replaced in the plating solution, and in the course of a few hours a coating of the thickness of tissue paper will be deposited upon it, having the beautiful matted appearance of dead silver.

If it is desired to preserve the dead surface, the object must be taken out, and immersed in boiling distilled water for a few minutes. On being withdrawn, it will dry immediately by its own heat, and then it must be placed under a glass shade, or otherwise protected from the action of the air, which, by forming a sulphide upon it, would tarnish it in a few days.

Mr. Gore remarks that the practical minutiæ of preparing the surfaces of various metals for receiving adhesive and non-adhesive coatings of different metals and in different liquids, vary considerably in different manufactories, and much information yet remains to be acquired respecting the particular methods required for particular metals and liquids, and from a want of this knowledge the most skilful operators occasionally fail in producing complete and strong adhesion, especially in coating Britannia metal, zinc, lead, tin or steel, with silver; iron or zinc with copper, &c.

Bright Deposit.—If a bright surface is wanted, this may be obtained either by burnishing, or by the addition to the silver solution of a little sulphide of carbon, which has the singular effect of throwing down a bright deposit. This remarkable fact was discovered in the following circumstances:—Some operators at the works of Messrs. Elkington and Mason were engaged in experiments upon elastic moulds, and whilst coating them with silver in the depositing vat, the deposits taking place upon the various articles in that vat were observed to present very peculiar and unusual appearances, some of them being exceedingly bright in different parts; these appearances were referred to the presence of the elastic moulds, and from the known existence of bisulphide of carbon in the moulds, experiments were tried of adding portions of that liquid to a quantity of plating solution, which finally ended in success, and a patent was taken out by Messrs. Lyons and Millward, March, 23, 1847. The best method of applying the sulphide is to put one or two ounces into a large bottle, and then fill it with strong silver solution; this mixture is allowed to stand for several days, shaking it occasionally, when it will be ready for use, and a little may be added to the plating solution as required.

Collodion and sulphur, sesquichloride of sulphur, or the hyposulphite of either potassa or soda, are also used for the same purposes, but to a less extent. A solution of iodine and gutta percha in chloroform is said to be more permanent in its effect than bisulphide of carbon.

Mr. Gore remarks, that a bright solution requires a large quantity and low intensity of battery-power to work it, and the anode in it is generally of a darker colour than that in the ordinary liquid. It is much more difficult to operate with than the ordinary liquid; if it is not worked constantly and uniformly, it will lose its power of yielding bright metal; if any one of the articles which are being plated in it is disturbed or removed from the liquid and replaced, that one will not again receive a bright deposit, and the disturbance of the liquid by removing it will oftentimes cause all the neighbouring ones to lose their brightness; or if too much brightening liquid is added, the solution will be considerably injured—indeed, many silver solutions have been totally spoiled in this manner.

But the silver is generally deposited *dead*, which admits of burnishing either the whole surface, or any particular parts of it, by mechanical means. In that case, the article is first brushed over with a wire brush and old ale or beer, and then subjected to the usual process of burnishing by polishing the surface with bloodstone or bright steel.

Small articles, such as spoons, knives, forks, snuffers, &c., are generally wired before they are cleaned, that is, they have small copper wires, size number twenty or twenty-two of the Birmingham brass wire gauge, and and about fifteen or eighteen inches long, twisted round them to suspend them by when in the vat, and to conduct the electricity; large articles, such as teapots, jugs, &c., are generally wired at some advanced stage of the cleaning process, after they have been scratched; and very large articles, such as fenders, hat-stands, large ornamental iron-work, &c., are not wired at all, but are suspended in the solution by strong copper or brass hooks; in cases where a very good and safe connection is required, the connecting wires are soldered to the articles.

It has been remarked, that when the article is *struck* in the silver solution, intensity batteries are used; but when afterwards immersed to receive the final deposit, batteries of volume are applied; or, in other words, batteries which furnish electricity in quantity, with greater or less intensity, according to the measure of resistance to be overcome. The power of the battery must vary according to the strength of the solution and amount of work to be done. In some of the large factories the vats or plating vessels measure about six feet in length, by thirty inches in breadth and depth, and contain about two hundred gallons of solution, having generally one ounce of silver to the gallon. The silver plates serving as electrodes are fixed upon light iron frames, which are not affected by the solution. These are attached at one corner to the rod, which is connected by a copper riband with the copper terminal of the battery; the plates are entirely immersed in the solution, and partially divide the vat into compartments, so that a silver surface is exposed to each side of the articles. The latter are suspended by cross-bars, forming a metallic communication with the longitudinal rod which is connected with the zinc terminal. The batteries are those of Smee or Wollaston, with plates about equal in length to the depth of the vat, and eight or nine inches in breadth. For a vat of the capacity above-mentioned, six batteries of three pair intensity are sometimes employed, the zinc plates immersed in the acid measuring six inches by seven.

To ascertain the amount of metal deposited, it is only necessary to weigh the articles carefully before and after the operation.

When old articles are to be replated, the silver that remains upon them must be taken off before they are subjected to a repetition of the process. This may be done either by chemical or mechanical agency. To remove the silver by the chemical method, the article is placed in a stoneware or

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copper vessel, containing some strong sulphuric acid, to which a little nitrate of potassa is added. This solution dissolves the silver without materially affecting the copper. When the silver is completely removed, the article is well washed, then passed through the alkaline lie, and the other preparatory operations for plating. The silver is recovered from the sulphuric acid when the latter is saturated with the metal, by adding a dilute solution of chloride of sodium, which throws down the silver as a chloride; this precipitate is then collected, and the silver is obtained in a metallic state by fusing with carbonate of potassa.

The mechanical method is generally preferred, and is performed in the factories by means of a hard circular brush, fixed upon a lathe, and a thin paste made of oil and fine pumice-stone powder. By this process, if skilfully managed, the article is not only stripped of its silver, but thoroughly smoothed and polished—a necessary preparation, which old plated articles are generally found to require, even when stripped by the acid process. It is therefore the preferable method to strip and polish the articles at one operation. The brushings are collected, and subjected to a red heat in an iron vessel, and that which remains after burning is fused with carbonate of soda and potassa to recover the silver.

In all cases of electro-deposition of metals, and especially in using the double cyanide solutions, the metallic deposit, which ought to be perfectly smooth, is often disfigured by vertical lines or ridges, produced by the constant upward current of the lighter parts of the solution which are set free. This is prevented by keeping the articles in motion, and different plans have been suggested for this purpose. The rods to which the articles and plates are suspended, are generally fixed into a frame, supported on four small wheels, which run upon a kind of rail formed on the edges of the vat. When steam power is at command, a gentle oscillating movement may easily be communicated to this frame; but when there is no engine, the same may be accomplished by clockwork or other devices. The superintendent of a plating establishment in Glasgow produces the motion by a bent lever, one arm of which is connected with the frame by a cord or wire, and the other carries a small pan, into which water is allowed to drop from the spigot of the pipe which supplies the vat. When a certain quantity of water accumulates, its weight overbalances the slight resistance produced by the action of the frame on the other arm of the lever; the pan, in descending, empties its contents; and the frame, which by the motion of the lever, had been drawn forward on its rail, returns to its place by the action of gravity, the rail being slightly inclined for that purpose; or if the rail is horizontal, the frame may be drawn back to its position by the action of a spiral spring, connected with the end of the vat. The retreat of the frame raises the pan, and the same operation is repeated without any care or trouble on the part of the person in charge. The simplicity of this ingenious contrivance is not the least of its recommendations. The dropping of the water is certain and constant in its action; whereas the operation even of a steam engine is liable to interruptions, and mechanism moved by clockwork is not only more complex, but is often brought to a stand by the simple neglect of the attendants to wind it up.

If a solution contains much free cyanide, and by any means the battery power becomes suddenly weak towards the latter part of the day, the silver deposited upon the articles will be redissolved off, because the liquid about the dissolving plates having by the day's work become saturated with metal, and that about the articles having become full of free cyanide, the two—that is, the dissolving plates and the articles—form a kind of voltaic battery, which circulates a current of electricity in an opposite direction to the original one, and thus redissolves the deposited silver. Care must be taken to guard against this accident; which, however, will not occur where motion is kept up.—*Dr. Muspratt's Chemistry.*

POLYTECHNIC INSTITUTION.

On Wednesday, the directors of this institution issued cards of invitation to their friends, to a *conversazione*, which was most numerously attended. Among the company present, we observed Professor Wheatstone, M. Peter Le Neve Foster, Lord Denman, Sir John Burgoyne, Sir Charles Rowley, Sir W. Mackenzie, the Rev. Charles Mackenzie, Sir Cusack Roney, Rear Admiral Lord C. Paget, M. P., the Hon. Mr. Langley, Rear Admiral Fitzroy, Captain Campbell, Sir John Logan, Major General Burn, Sir S. D. Scott, Dr. Frankland, Dr. Spurgin, Dr. Holby, Dr. O'Connor, the Rev. Dr. Bremner, Mr. Devonport, the Rev. S. Smith, their Serene Highnesses the Prince and Princesses of Gonzaga, Dr. Hoffman, Mr. Montagu Scott, Mr Coleman Burroughs, Signor Collini, Mr. John Taite, Mr. Otho Thwaites, Mr. Edwin Wright, Mr. George Edwin, &c., and a vast number of ladies. The lecture by Mr. Pepper was enthusiastically received, and the electrical experiments were very beautiful, and were all successful; various experiments being made with the large plate-glass machine stated to have been originally constructed for the Emperor Napoleon I. There was a concentration of numerous powerful batteries, including the whole of the voltaic batteries of the institution, and others lent by kind friends of the Polytechnic; Captain Bolton's system of oxy-hydrogen-light signals with the portable apparatus; also his system of indicating light-houses. On this occasion signals were passed from Highgate Church to the Polytechnic Institution. Mr. Ward exhibited his system of signals; and Gore's aoparatus for showing vibrations in mercury by electrolysis, by Mr. Heisch. Various large electro-magnetic coil machines—a splendid series of experiments were shown with this apparatus. Messages were interchanged during the evening, the following companies having kindly lent their wires for this occasion:—The London District Company, the Magnetic Company, the Submarine Company, and the Universal Private Telegraph Company. The great hall of the Institution was illuminated by four electric lights, exhibited under prismatic glass shades, expressly manufactueed for this occasion, by Messrs. Defries, the glass-chandelier manfacturers, of Houndsditch. The lamps were constructed by Duboscq, Serrin, Heisch, Elliott, and Squires, and were worked by Mr. Samuel Highley. Works of art were provided, in silver, electro-plate, and gold, by Messrs. Hunt and Roskell and Messrs. Elkington. Mr. Appold kindly exhibited curious experiments showing the elasticity of iron, and also that water may be reduced 20 degrees below 32 deg. without being frozen. The entertainment commenced with a concert, the conductor being Mr. George Buckland, and the vocalists assisting him were Miss. Susanna Cole, Miss Elton, Mr. Henry Buckland, and Mr. Rogers. A solo by Gratten Cooke was loudly applauded. The company separated highly pleased with the intellectual treat they had enjoyed.

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July 17, 1862. Wm. Kirkmann,

4, *Howford Buildings, Fenchurch Street, E.C.*

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of The Electrician.

Sir,—In reference to the concluding remarks of your article on Magneto Machines, you say that the wire, instead of being placed on armatures, may be put on the permanent magnet, and the circuit of the magnet be closed and opened by a separate armature. Do I understand that the wire may be coiled on each arm of the magnet, instead of being coiled on any armature? My reason for asking this question is, that a short time back I asked you to give me an opinion of a contrivance for producing induced magneto-currents, when the wire was coiled on the magnet, and your reply was, that making and breaking contact with a permanent magnet would not give induced currents. If I understand your article correctly, it leads me to suppose that it will do so.—Yours respectfully, J. Cook.

[You are *right*, and our answer to your former inquiry (p. 251) is *wrong*, and should be corrected. A current *is* produced by making and breaking coneact with the armature of a permanent magnet within a helix of wire. The effect being dependent upon the difference between an open magnet and a closed one, instead of between a closed magnet and a piece of soft iron without magnetism, is necessarily much weaker, under similar circumstances, than the current from a magneto induction machine, as commonly arranged.—Ed. E.]

To the Editor of The Electrician.

Sir,—Thanks for your reply to my letter. Can you inform me what law governs the length of the spark, and what is the reason the attractive power of the conductor of an electrical machine is felt far beyond the distance the spark will reach; also, why such is not the case with a thunder cloud?

How is it that a cloud charged with electricity either exerts no attraction at all on substances on the surface of the earth, or acts so powerfully as to root up trees and unroof houses?—Yours respectfully, X.

Haverfordwest, July 14th, 1862.

To Correspondents.

L. L. S.—By attaching a collar of lead with binding strip to the graphite plates, placing them in porous vessels with pure nitric acid, and surrounding them with cylinders of amalgamated zinc in dilute sulphuric acid, you will have a Bunsen battery. For the purpose you speak of, they should be arranged for intensity. If you wish to use the six cells of Smee with the above, the best plan would be to unite them two by two for quantity, and then join up the double cells for intensity.

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The Electrician.

VOL. II. No. 38.—JULY 25, 1862.

CONTENTS:

	PAGE		PAGE
On the Comparative Periods of Charge of various lengths of Submarine Cable	133	The Colony of South Australia	140
Report of the Directors of the Telegraph to India Company (Limited)	134	On the Allotropic States of Oxygen, and "Nitrification"	140
On the Electrical Qualifications requisite in long Submarine Telegraph Cables	136	Prices Current of Insulating Materials	141
Hearder's Printing Telegraph	138	Telegraph Shares	141
Electro-Gilding	138	Colonial and Foreign Telegraphy	141
		Telegraphic News	142
		Correspondence	142
		Miscellanea	144
		To Correspondents	144

ON THE COMPARATIVE PERIODS OF CHARGE OF VARIOUS LENGTHS OF SUBMARINE CABLE.

WE will continue our analysis of the conditions which modify the period of time necessary to communicate the full amount of charge from a given battery, to various lengths of wire under similar circumstances for electrical accumulation, and which affect therefore the degree of retardation in the transmission of signals. These conditions, on first consideration, may appear somewhat complex, but are well worthy of the attention of telegraphists.

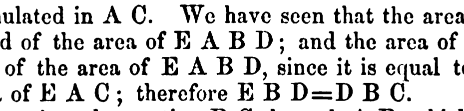
Referring to the diagram given below, we may recapitulate a few of the facts relating to the inductive charge in submarine cables, which are given *in extenso* in the Supplementary Report of Mr. LATIMER CLARK, accompanying the Report of the Submarine Telegraph Committee, and which are familiar to most of our readers.

1. If we represent by A C a length of cable connected to earth at one of its extremities C, and to the pole of a battery at its extremity A, the other pole of the battery being connected to earth, and if we represent the degree of tension at the point A by the perpendicular A E; the distribution of the charge in the wire will be shown by the line E C, and the tension at any point B will be shown by the perpendicular B D.

2. Supposing the cable now to be divided into two halves, the section nearest the battery will hold three times the quantity of electricity accumulated in the section nearest the earth. The distribution will be as the area of E A B D for the section A B, and as the area of D B C for the section B C. In a cable divided into a greater number of equal sections, the distribution of the charge in each section respectively, beginning at that which is furthest from the battery, will be in the ratio of the numbers 1, 3, 5, 7, 9, &c.

3. Let us now make contact with earth at the point B. Supposing the resistance of the battery to be infinitely small in comparison to that of the wire A B, the distribution of the charge on this conductor will be shown by the line E B. Strictly speaking, in proportion to the amount of resistance of the battery will the tension at A, represented by A E, and consequently the amount of charge, become reduced.

Fig. 1.



4. Abstracting the resistance of the battery, the quantity of electricity accumulated in A B will be one half of that which was accumulated in A C. We have seen that the area of D B C = one-third of the area of E A B D; and the area of E B A = two-thirds of the area of E A B D, since it is equal to one-half of the area of E A C; therefore E B D = D B C.

5. In charging the section B C through A B, which we suppose to be already charged, a quantity of electricity equal to that accumulated on A B will be supplied from the battery. Of this quantity, one half will be distributed on A B, and the other half upon B C, thus giving the proportion in the amount of charge of 3 to 1.

In reference to the proposition that the flow of electricity in a wire to effect a static charge is subject to the same law as the flow of electricity in a closed circuit, *i. e.*, that it is directly as the electromotive force, and inversely as the sum of the resistances, or as $\frac{E}{R+r}$, we may quote the following from the *Traité d'Electricité* of M. Gavarret:—"When each pole of an insulated battery is placed in communication with an insulated conductor, the volume of which may be considered as infinite as compared to that of the electromotor, a true *current* of positive electricity (*i. e.* a current in one direction), will be produced from the copper pole, and a negative current (*i. e.* a current in the reverse direction), from the zinc pole. The current will take place as though the circuit of the battery were closed by a continuous conductor uniting its poles." We believe that this view is now generally, if not universally, accepted; and we hold, moreover, that a true voltaic current takes place when the capacity for charge of the insulated conductors, or of one of these, cannot be regarded as infinite; the momentary flow of electricity being duly indicated by the galvanometer. It may be stated also as a fact, susceptible of experimental as well as theoretical demonstration, that the period of time occupied in charging a Leyden condenser to the tension of the pole of a given electromotor is inversely as the resistance interposed between the condenser and the battery.

Let us now endeavour, from the above data, to ascertain the comparative periods of time which would be occupied in effecting the charge of A B and A C respectively. According to the view that the period occupied in the charge of various lengths of wire is as the squares of these lengths, the following reasoning would, we believe, be adopted:—

The resistance of A B being half that of A C, we may represent the former by the number 5, and the latter by 10. The quantity of electricity which would circulate through A B and A C respectively being inversely as their resistances, will be as 10 for A B, and as 5 for A C. Applying these numbers to represent the active force in effecting the charge we have in the case of A B

A (active force) =10, Q (quantity of charge) =50.

Time occupied in charge $=\frac{Q}{A}=5$;

and, in the case of A C,

A=5, Q=100. Time of charge $=\frac{Q}{A}=20$; the periods being as the squares of the respective lengths.

The inequality of the distribution in the two halves of A C respectively appears to be here disregarded; the calculation being applicable to the case in which the whole of Q might be accumulated on the surface of a condenser at the point C.

According to the view based on the method of analysis, we have referred to, the conditions in charging the *wire* are essentially different. It appears sufficiently obvious that the supply of electricity to A B must take place under any circumstances irrespective of the resistance of B C. To make this point, if possible still more clear, we will suppose a Leyden condenser to be attached to the conductor at B; the period occupied in charging this condenser through the resistance of A B will not be affected by adding to or diminishing the *resistance* of B C. Again, if the active force in charging this condenser is as the electro-motive force of the battery divided by the resistance of A B (neglecting the resistance of the battery), the active force under which this portion of wire becomes charged must be greater than $\frac{E}{5}$; whereas by the above reasoning it is supposed to be $=\frac{E}{10}$, when A B and B C are simultaneously charged.

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By dividing any cable into a number of sections of given length, representing units of resistance, we may approximate very closely to accuracy in calculating the comparative periods of time which would be occupied in charging various lengths of the wire. We have seen that the quantity of electricity accumulated in any section may be easily arrived at; and this quantity multiplied by the number of units of resistance between the section and the battery, including the resistance of the section itself, will give, approximatively, the relative period of time which will be occupied in charging this particular section.

It is obvious that we cannot pretend to any degree of accuracy in calculating the periods of time which would be occupied in charging respectively A B and B C, in the above diagram, where the total length of wire is divided into two sections only. We may, however, illustrate by means of this diagram the approximative method of calculation we have pointed out. The resistance of each section being equal to 5, we may express the active force under which A B becomes charged as 10, and the active force in charging B C as 5. The period in which A B becomes charged when contact with earth is made at $B = \frac{Q}{A}$. The quantity of electricity accumulated under these conditions in A B we will express as in the former case by 50. A B will therefore become charged in 5 units of time. When A B and B C are charged simultaneously, we may consider separately the charge of the two sections. The quantity of electricity accumulated in this instance will be double that in the former case. Of this double quantity, however, three-fourths, equal to 75 units, will be accumulated on the section A B, and will not therefore be affected by the resistance of B C. The charge of the section A B will take place therefore in $7\frac{1}{2}$ units of time. The charge of B C, equal to 25 units, will be effected under a charging force $\frac{Q}{A} = \frac{25}{5}$, and will occupy 5 units of time.

According to these data, if the length A B takes 5 units of time in charging, A C will take $12\frac{1}{2}$ units of time. We do not give these results as approaching at all to accuracy; but merely as those which would follow from a very rough analysis of the effects of charge. By adopting a more minute system of analysis we may approximate somewhat more nearly to the ratio of the squares; and, as we have in view simply the elucidation of truth, by means comprehensible to ordinary students of electricity, we shall be glad if the results we obtain are more or less in accordance with those which have been arrived at by others.

REPORT OF THE DIRECTORS OF THE TELEGRAPH TO INDIA COMPANY (LIMITED).

Submitted to the Proprietors at the First Ordinary General Meeting of the Company, on the 25th July, 1862.

IN convening the Shareholders together the Directors have acted on the view that it would be satisfactory to their Proprietary to assemble in General Meeting at as early a period as possible after the return of Mr. Latimer Clark, one of the Company's Engineers, from the Red Sea, in order to consider and discuss the subject of his report on the examination of the cable.

It is unnecessary for the Board on this occasion to refer, in any detail, to the circumstances under which the Company was formed, nor to the arrangements by which they became possessed of their present property, as these were fully set forth in the prospectus.

It will be sufficient to state that the requisite amount of capital having been subscribed, and the condition imposed by the Government on the formation of the Company—that a ship should be despatched to Aden with 200 miles of new cable—having been complied with, the Lords Commissioners of the Treasury authorised the transfer of the whole of the Lines and property of the Red Sea and India Telegraph Company to this Company, and that the arrangement has been confirmed by Parliament. Mr. Latimer Clark proceeded at once to Egypt by the Overland Route, whilst the steamer *Sir James Duke* was sent round the Cape, with the 200 miles of new cable on board, as required by the agreement with the Treasury.

Mr. Clark arrived at Alexandria in the month of January, and during his stay in Egypt he made arrangements for opening the land Line between Alexandria and Suez, which had been inoperative since the failure of the Red Sea cable, and obtained from His Highness the Viceroy of Egypt the valuable privilege of transmitting local messages throughout the interior of Egypt, from which he saw that a considerable business might be expected.

The cable in the Gulf of Suez was next examined, and being found to be in good order as far as Jubal Island, at the entrance of the straits, a station was established there and arrangements were made, with the concurrence of the Postmaster-General and the Directors of the Peninsular and Oriental Company, by which the mail steamers on their passage up and down the Red Sea call at the station for the exchange of despatches, so that the whole telegraphic communication between Europe and the East passes over the Company's Line.

The Jubal Line was opened on the 7th of March, and the Directors are happy to report that the pecuniary results have been most encouraging.

The number of messages up to July 2nd amounted to 2,457, and the Company's proportion of the receipts to £1,540 0s. 3d., whilst the steady increase in the weekly returns shows that a revenue of about £7,000 per annum may be expected upon this small section of the Company's Line alone.

The Jubal Line having been established, Mr. Clark proceeded to Aden, where he met the *Sir James Duke*, and commenced the examination of the Line between Aden and Kurrachee.

The result of his investigation will be found in the Report of the Engineers, which is annexed, from which it will be seen that the Line is in such a state as to render it unadvisable to attempt the repair of the existing cable.

The outer iron wires were found in many places to have been completely corroded, and the cable, wherever it depended on their support, had broken under its own weight, and the Engineers decided, after full consideration, to recommend the Board to bring the new cable home. Orders were accordingly sent for the return of the *Sir James Duke*, with the whole of the new cable, and any portion of the old which might have been picked up during her stay at Aden.

It is satisfactory to find that the core of the submerged cable, consisting of copper or gutta percha, on which the electrical value of the cable depends, was found to be generally uninjured.

The Engineers report that the soundings on the south coast of Arabia have not hitherto been taken to a sufficient extent to justify measures for laying a cable, and suggest that before any fresh attempt is made to lay a line between Aden and Kurrachee a thorough survey should be made of the whole route. The Directors have called the attention of Her Majesty's Government to this subject, and it is hoped that one of the vessels of war on the Red Sea station will be ordered to make the survey, as was done in the case and Malta and Alexandria Line.

The Shareholders will thus perceive that the project of repairing the existing Line between Aden and Kurrachee is practically out of the question.

Turning to the Red Sea, the Line from Alexandria to Jubal has worked well, and from the gradual increase in the traffic it may be expected to yield a good dividend upon the whole amount of capital expended by the Company. At the same time it should be stated that two interruptions have taken place, one of which was speedily repaired. News has, however, been received that the line is again interrupted near Suez, but from the position of the fault, which is in shallow water, the Directors have every hope that it will be easily made good.

During the interruption, the messages are transmitted to and from the Company's Station at Suez by their land line through Egypt.

Under these circumstances the policy of extending this line ot Aden, as referred to in the Engineers' Report, either by continuing the land line from Cairo to Kosseir only, which can be accomplished without difficulty, and laying a new and more substantial cable from Kosseir to Aden, or by extending the land line to Suakin, and using the present cable from thence to Aden, is one requiring grave consideration, and involving many important questions.

In order to be prepared as far as possible for a decision on the subject, the Board have had an estimate made of the cost of the extension.

The cost of a land line from Cairo to Kosseir, and of a new and permanent cable from thence to Aden, is estimated at £390,250. This amount would, however, be reduced by employing the new cable now in hand, and any portion of the old cable that can be profitably recovered, and still more so if it should be found practicable to substitute a further portion of land line.

A new difficulty has, however, sprung up since the formation of the

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Company. The views of the Government at that time were to establish the communication with Kurrachee by the Red Sea route. Within a recent period it has been ascertained that the Indian Government have determined to continue the line from Bagdad by the Persian Gulf to Kurrachee, and have in their estimated expenditure appropriated £230,000 for this purpose. This line can be laid at a considerably less cost than that from Suez by Aden to Kurrachee, and would, therefore, not only be a competing line, but would be capable of being worked at a cost to preclude a fair competition.

With this contingency before the Company, the Directors are not prepared to recommend that any steps should be taken for the present beyond keeping open the communication between Alexandria and Jubal, until they are able to ascertain the views of the Government in relation to the line in the Persian Gulf, and they will lose no time in bringing the whole question under the notice of the Lords Commissioners of Her Majesty's Treasury, as one requiring an immediate solution.

The Directors cannot too strongly express their high sense of the exertions of Mr. Latimer Clark, and of his staff, during the entire period of the investigations, and have great pleasure in referring to and acknowledging their valuable services.

The Directors have to report that the Red Sea and India Company's Bill has passed through Parliament, by which the arrangements between Her Majesty's Government and this Company, and the transfer of the property, is confirmed.

An amendment was added in the House of Lords, binding the new Company to fulfil the terms of the agreement with the Treasury, a condition which in no way extends the existing obligations of this Company. The cash balance to be handed over by the Red Sea and India Telegraph Company to this Company, will more than cover the amount of the liabilities which the latter have undertaken to defray.

The Accounts and Balance-sheet to June 30th are laid before the Shareholders.

In compliance with the requirements of the Joint Stock Companies Act, the first Directors of this Company retire at this Meeting, and offer themselves for re-election.

The auditors, Mr. J. A. Franklin and Mr. A. S. Wildy, also retire, and offer themselves for re-election.

MACDONALD STEPHENSON, *Chairman.*
C. L. PEEL, *Secretary.*

REPORT OF THE ENGINEERS.

To the Directors of the Telegraph to India Company.

GENTLEMEN,—We beg to inform you that Mr. Latimer Clark has returned from India, having completed his examination of the Red Sea and Indian Telegraph Cable, and having left our assistant, Mr. J. C. Laws, with the steamer *Sir James Duke* at Aden, with instructions to continue picking up the cable in that vicinity until further orders.

On his arrival in Egypt his first endeavours were directed to the restoration of the Company's land lines or that portion of the Red Sea cable lying in the Gulf of Suez. With this view he placed himself in communication with the government of His Highness the Viceroy of Egypt, from whom he received the most earnest co-operation and assistance, and to whom the thanks of the Company are due. Arrangements were made by which the Company acquired the right of transmitting messages throughout Egypt, and stations have already been opened at Alexandria, Cairo, and Suez.

Successful endeavours were at the same time made to repair the cable between Suez and the Island of Jubal, at the mouth of the Gulf of Suez, and a station and clerks were established on the island, at which the passing steamers regularly receive and give up their messages. The revenue from these sources already amounts to the rate of about £7,000 per annum, and is steadily increasing. The line since its completion has been once interrupted, but from the generally soft nature of the bottom on which the cable is laid, and the shallow soundings of this portion of the sea, and the amount of slack in the cable, it is confidently believed that such an interruption is not likely to recur frequently. Due provision has been made for its prompt repair in case of failure.

Expeditions were simultaneously organized for the survey of the land routes, by the Nile and the caravan route, across the desert to Kosseir, and also along the western coast of the Red Sea, His Highness the Viceroy of Egypt having accorded to the Company the right of carrying telegraphs by either of these routes, and having liberally placed at their disposal a steamer to convey the party up the Nile, and promised every future assistance. The Nile and desert route appears in every way suited for the establishment of an Electric Telegraph, and the Bedouin sheikhs being few in number, powerful and ready, in consideration of a small subsidy, to enforce a most rigid respect and protection for the Line.

The examination of the sea-coast Line from Suez to Kosseir, and to a point nearly 200 miles further southward, proves that a telegraph is equally practicable by this route. The coast almost everywhere forms a plain, from one to three miles in breadth, along which an ancient road extends, probably of Roman construction, sufficiently broad for several carriages to travel abreast, and water is found at intervals of a day's journey. Although not well suited for the residence of Europeans, and nearly uninhabited, the natives apprehend no difficulty in residing there all the year round; they are under the same sheikhs as those on the caravan route. South of Kosseir the coast becomes flatter, and the inhabitants present the same character and the same mode of government; there was not time to survey this portion of the coast, but from inquiries amongst them there appears reason to believe that arrangements may be made for the safe maintenance of a land line as far as Suakin.

The Island of St. John's, which is favourably situated for the establishment of a station, was twice examined by Captain Dayman, R.N., but from his reports, which are confirmed by our inquiries, it appears that in consequence of the island being entirely surrounded by coral reef, there would be almost insuperable difficulties in maintaining boats there, or in communicating with the passing steamers during stormy weather. Captain Dayman also visited several points on the eastern or Jeddah coast of the Red Sea, with a view to the establishment of a land line along that coast, but every testimony shows that the natives are too fanatical and too loosely governed to allow of the safe maintenance of a telegraph through their territory; the same observations apply in a still higher degree to the southern coast of Asia, between the Red Sea and Muscat. The submarine route from Suakin to Aden is well suited for the deposit of a cable, and Captain Dayman considers that the soundings already existing are sufficiently accurate to enable a good 80 or 100 fathom line to be chosen for the cable.

We carefully tested and examined the cable between Aden and Kurrachee; but in no instance did we find a length of 100 miles entire. The electrical condition of the copper and gutta percha core was generally so good, that, when properly covered, it is fit for resubmersion; but owing to the entire absence of all protection, the iron was corroded away that the cable where suspended over rocks or submarine valleys, gave way, spontaneously breaking up into short lengths. This effect was expedited in many instances by the quantity of barnacles and shells which adhered to, and surrounded it, but more especially by the extreme and injudicious tension under which it had been originally laid, which was so great, that in some cases not more than 25 per cent. of the cable had rested on the ground, and in one instance a length of 1,200 feet was hanging suspended in a catenary. Having tested the line through, from Aden to Kurrachee, and finding that it would be hopeless to attempt to repair more than one section of the line with the cable on board the *Sir James Duke* (even the Muscat and Kooria Mooria section having failed like the others), and that similar interruptions would certainly occur again if any section should be repaired, Mr. Clark deemed it imprudent to attempt the repair of the line, and resolved therefore on the recovery of a portion of the cable, to help to defray the cost of the expedition. This resolution was, however, arrived at too late to permit of much being done, for the monsoons commenced, and up to the present time only twenty-six miles have been recovered; the work is still proceeding, and until the return of the expedition we cannot form a trustworthy estimate of the quantity likely to be ultimately regained at a profitable rate. The southern coast of Asia appears everywhere well suited for the submergence of a submarine line, and it is perhaps superfluous to say that modern improvements enable us with certainty to undertake to lay a cable which will not be liable to injury by corrosion, or to the electrical failures which the former imperfectly designed cable experienced. The latter cable was laid without much apparent regard to the nature of the bottom or the depth of the soundings, and we consider that the existing charts of that coast are much too imperfect to admit of the selection of a suitable line for the cable. We therefore recommend that minute and careful surveys should be made with special reference to this object, and that a suitable line, varying from 60 to 100 fathoms in depth, should, where possible, be chosen for the cable, free from rocks or coral, and that extra strong cable should be laid over the rocky portions of the Line.

We are, Gentlemen, yours faithfully,
BRIGHT AND CLARK.

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THE TELEGRAPH TO INDIA COMPANY, LIMITED.

Statement of the Capital Account from 17th October, 1861, to 30th June, 1862.

DR. CR.

EXPENDITURE.	£	s.	d.	RECEIPTS.	£	s.	d.
Cable (new) on board of the S.S. *Sir James Duke* ...	21000	0	0	Capital realized, viz.:— Deposit of 20s. per share on 45,175 shares ...	45175	0	0
Examination of old cable (eastern section) :—							
Charter of S.S. *Sir James Duke*	8559	15	4				
Fittings of steamer chains, ropes, and other stores	1485	15	0				
Wages of Staff	1612	4	6				
Travelling expenses and victualling	1236	10	2				
Engineering charges ...	2021	4	0				
Establishment of stations ...	543	7	10				
Hire of S.S. *Gabari*, and coals	1428	7	0				
Advertisements, printing, stationery, and books	975	11	3				
Rent and repairs, office charges, postages, travelling and incidental expenses	227	19	3				
Commission on remittances ...	200	8	6				
Messenger's wages and extra services	61	6	7				
Salaries abroad and allowance for quarters	122	4	0				
Furniture, fittings, &c. ...	20	13	3				
Land Line inspection and maintenance...	75	19	11				
Repairs of cable	1	4	0				
Repairs and maintenance of instrument and batteries ...	1	10	11				
Insurance	1690	11	8				
Law charges	50	0	0				
	£41314	13	2				
Amount of outstanding Accounts	4826	18	5	Balance ...	966	11	7
Total...	£46141	11	7		£46141	11	7

DR. *Statement of the Revenue Account from 7th March to 30th April, 1862.* CR.

EXPENDITURE.	£	s.	d.	RECEIPTS.	£	s.	d.
Compensation (returned message money)	14	18	7	Amount of message money ...	462	2	0
Land Line inspection and maintenance	33	5	4	„ transfer fees... ...	3	2	6
Salaries abroad and allowance for quarters	223	4	2	„ interest	59	18	11
Exchanges...	7	12	4				
Rent and repairs, office charges, postages, &c.	117	11	0				
Repairs and maintenance of instruments and batteries ...	29	13	5				
Printing, stationery, books ...	1	17	0				
	£428	1	10				
Balance	97	2	4				
	£525	4	2		£525	4	2

DR. *Balance Sheet of the Company made up to the 30th June, 1862.* CR.

	£	s.	d.	£	s.	d.
CAPITAL :—						
Amount received on account of 45,175 shares ...				45175	0	0
LIABILITIES :—						
Bills payable ...	£611	0	6			
Owners of the S.S. *Sir James Duke*	3700	0	0			
Peninsular and Oriental Company	1093	10	2			
Sundry accounts	597	7	5			
				6001	18	1
Net Revenue (7th March to 30th April) :—						
Balance of Revenue Account	525	4	2			
Less expenses chargeable thereon ...	428	1	10			
				97	2	4
				£51274	0	5

	£	s.	d.	£	s.	d.
EXPENDITURE :—						
Amount chargeable against Capital, as per accompanying Statement of the Capital Account				41314	13	2
Amount of outstanding accounts				4826	18	5
				£46141	11	7
Cash Balance, viz.:—						
At the Bankers'	£1803	7	6			
„ Bank of Egypt... ...	900	0	0			
In the hands of the General Superintendent, the Engineers, and other officers of the Company...	2429	1	4			
				5132	8	10
				£51274	0	5

The following Property may be considered as Assets of the Company.

New cable on board the S.S. *Sir James Duke.*
Old cable picked up by the S.S. *Sir James Duke.*
Submarine instruments and batteries complete for eight stations.
Land Line in Egypt (220 miles).
Freehold house at Aden.
Furniture for eight stations.
Land Line at Kurrachee (sixteen miles).
Cash Balance to be received from the Red Sea and India Telegraph Company.

MACDONALD STEPHENSON, *Chairman.*
C. L. PEEL, *Secretary.*

Examined and found correct,
RD. MILLS

Treasury, 17*th July*, 1862.

We have examined these Accounts, and find them in correspondence with the Books of the Company; the Receipts and Payments in England being vouched for in detail—those in Egypt, &c., by the Company's Agents respectively.—*London*, 17*th July*, 1862.

J. A. FRANKLIN,
A. S. WILDY.

ON THE ELECTRICAL QUALIFICATIONS REQUISITE IN LONG SUBMARINE TELEGRAPH CABLES.

BY THE LATE SAMUEL ALFRED VARLEY.

THERE seems to be a great deal of uncertainty, in the minds of those engaged in applying electricity practically, regarding the laws of conduction and induction; and consequently of the nature of the conductor which should be employed for long submarine circuits. A careful study of the conclusions arrived at by the projectors of the Atlantic cable, leads to the belief, that some errors have been inadvertently introduced into their calculations; but the author trusts, that if in the course of this paper he is led to criticise any of these results, his remarks will be received in a friendly spirit, as they originate solely from a desire to arrive at the truth.

The laws of conduction which electricity obeys in its passage through a conductor have been ascertained by the author, as the result of experiment, to be—First, that a wire 1 mile long offers exactly half the resistance, of a wire 2 miles long; and Secondly, that two wires, each two miles long, when placed side by side, which is the same thing as one of double the area, oppose the same amount of resistance, as one wire 1 mile long.

With regard to induction, experiments instituted and carried out by the author, in conjunction with Mr. C. John Varley, gave the following results:—with flat plates induction follows the same law as conduction, decreasing in regular proportions, as the insulating medium is increased; that is to say, if the inductive force through one plate is twelve, through two plates it will be six, through three plates it will be four, and so on. In a gutta percha-covered wire, it probably does not follow precisely the same law, for when the insulating materials are increased in thickness, the outside surface of the gutta percha is also enlarged, which partly counteracts the beneficial effect of the greater thickness. Mr. Cromwell Varley states, that some experiments tried by him, to ascertain the law which induction follows, under such circumstances, went to show, that in a wire one-tenth of an inch in diameter, coated to the depth of one-tenth of an inch with gutta percha, making a total diameter of three-tenths of an inch, when compared with one of the same size, but coated to the depth of two-tenths of an inch, making a total diameter of five-tenths of an inch, the inductive force of the former was to the latter as 4 to 3¼, or thereabouts, and not as 4 to 2. There is, however, some difficulty in obtaining accurate results, so that this must be considered only as an approximation.

The first general deductions from these laws would be, that the larger the sectional area of the metallic core of the cable, and the thicker the insulating materials, the more efficient will be the conductor. The projectors of a submarine telegraph have, however, to regard the expense, facility of carriage, and other points tending to limit the size of the cable, as well as its electrical capabilities.

Those who have had the management of the Atlantic cable, have no doubt attentively considered the subject in all its bearings, and have adopted what they conceive will best fulfil all these conditions. The conclusions they have arrived at are, that no adequate result is obtained by increasing the sectional area of the metallic core, and, moreover, that a large wire conducts more slowly than a small one, in submarine circuits. They say that science has shown, "that large-coated wires used beneath the water, or the earth are worse conductors, so far as velocity of transmission is concerned, than small ones, and therefore not so well suited as small ones for the purposes of submarine transmission of telegraphic signals."

The author conceives there must be some error in these results; but before giving his reasons for thinking so, it will be necessary to direct attention to a few facts, relating to the quantity and tension of an electric current. If a battery of six cells is connected through a short circuit of nominally no resistance, a much greater quantity of electricity will pass, than when connected through a perfectly-insulated fine wire of very great length, and opposing, therefore, great resistance to the passage of the current. If a battery with the same number of cells, but with twice the extent of surface in each cell, and capable, consequently, of generating, through a circuit of nominally no resistance, double the quantity of

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electricity, be connected through the same wire, practically no more will pass than in the former case, the resistance of the wire measuring out the quantity of electricity which flows through. It is almost the same thing, as water flowing out of a small pipe, inserted into the bottom of a cistern; the rate at which it flows being dependent, not on the quantity of water in the cistern, but upon the height of the column. If the series is increased, more will be forced through the circuit, and cell by cell may be added, until, for all practical purposes, as much will be developed through the long fine wire, as the battery originally generated, when on short circuit. Theoretically, this could never be attained. A further addition to the series will not make any perceptible increase in the quantity flowing, for there is already power enough to force through all that the battery is capable of generating, and the amount of force given out is always proportionate to the dynamic quantity flowing through the instruments. Intensity is only the medium by which this dynamic quantity is forced through. This is an important fact to be borne in mind.

The three following conclusions seem also to have been arrived at by the projectors of the Atlantic cable:—First, that an insulated submarine wire conducts according to a different law to that of a suspended circuit; Secondly, that the rate at which a voltaic signal travels along a wire is not affected by the intensity of the battery; and Thirdly, that magneto-electric induced currents have the property of travelling much faster than voltaic ones, and increase in the rapidity of travelling, when their intensity is increased. In examining these conclusions, it has first to be considered, whether the conditions of a submarine circuit and of a suspended one are different. In a suspended wire, the insulating medium of the air takes the place of the gutta percha of the submarine circuit. The earth, which is the nearest conductor, is a considerable distance off, and is only on one side of the wire; therefore, but little induction can take place between the wire and the earth. Nevertheless, induction to a certain extent does take place, and can be perceived in circuits of very moderate length. The author has noticed indications of it in a circuit 60 miles long, and he feels confident that, with delicate apparatus, it could be perceived in much shorter circuits. If the distance between the wire and the earth is decreased, induction will be developed more strongly, and the wire could be brought down, step by step, until the condition of a submarine circuit would be approached, where the earth surrounds the wire on all sides, and is only separated from it by the thickness of one-eighth, or three-sixteenth of an inch of gutta percha, a substance possessing, moreover, specifically a much greater inductive capacity than air. It therefore appears that the conditions are precisely the same, only differing in degree. Before proceeding further, and to prevent the possibility of mistake, it is advisable to make the following quotation from the work previously referred to:—"The law of the squares may possibly apply to the transmission of electricity freely along simple conducting wires, but it certainly does not apply to the case of its transmission along submarine or subterranean gutta percha-covered wire (the facility of transmission being estimated by rate of speed), because in this the case is not one of simple conduction, but of transmission after the wire has been charged inductively to saturation as a Leyden jar." This quotation shows clearly, the reason for concluding that small wires are better conductors for submarine circuits, as far as transmission is concerned, than larger ones; for the smaller the Leyden jar, the more quickly will it be charged to saturation. The author, in differing from these conclusions, does not wish it to be understood, that he thinks the law of squares is applicable to submarine wires; for he is not aware of any electrical phenomena which obey that law. But he submits, that there is a material difference between a Leyden jar and a submarine wire. In a Leyden jar, the inner and outer coatings are perfectly insulated one from the other. If they were not insulated, there could be no statical charge, as is well understood by all electricians. Induction, therefore, involves insulation. But in a submarine circuit this is not the case. If the wire was disconnected at the further extremity from the telegraph instrument, and was sealed up with gutta percha, the conditions would be nearly the same. In practice, however, it is quite open through the instrument to the earth, and the resistance opposed by the very long length of wire, is the only insulation between the inner and outer coatings; for it unites both, being in connection with the earth at both ends. It is, therefore, evident, that if the wire offers no resistance, there will be no insulation, and, as a consequence, no induction to retard the passage of the current. It is also equally plain, that precisely in proportion to the resistance which the wire opposes, provided always the insulating medium is of the same thickness, will induction manifest itself, and retardation be experienced. There is also another difference between a Leyden jar and a submarine circuit. The Leyden jar is charged uniformly all over, whilst in a submarine wire, the tension of the charge varies in different portions of the circuit; being at its maximum at the end where contact with the battery is made, and gradually vanishing to nothing at the further extremity.

The fact has already been adverted to, that if a battery capable of developing, when in short circuit, a much greater quantity of electricity than it does when connected through a fine wire, is connected through a long wire of small dimensions, the quantity evolved through one length of this fine wire, will be twice the amount of that evolved through double the length. From this it appears, that double the length of wire opposes the same resistance to a given quantity of electricity, as a wire of half this length does to double that quantity of electricity. Hence any length of wire opposes an infinitely small amount of resistance to an infinitely small quantity of electricity.

An idea seems to prevail, that if the wire becomes attenuated at any one spot, the conducting power of the whole circuit will be brought down to that of a wire of no greater thickness than it is at the attenuated portion. It will be at once seen, from what has just been said, that this cannot be the case; but that the effect will be precisely the same as increasing the length of the circuit. For if the circuit is attenuated, say throughout a mile of its length, to half its normal diameter, it will possess, in this space, only one-fourth of the sectional area; consequently, it will oppose four times as much resistance as a mile of wire of its original size. In other words, this mile will oppose as much resistance as 4 miles of any other portion of the circuit. If the resistance, offered by one mile of the circuit, is put down as 1, then the resistance opposed by the attenuated mile would be 4; and if the normal resistance, or 1, is subtracted from this, there will remain 3, as the excess of resistance over what it should be, owing to this attenuation. The effect will therefore be the same as increasing the length of the circuit by 3 miles. It seems surprising that this should have escaped observation, for if true, the conducting power of the whole circuit would be brought down to that of a wire of no greater diameter than that made use of in the coils of the instruments, which may be considered simply as a continuation of the cable, and is only about one eightieth of an inch in diameter. Electricity flowing through a long circuit which is attenuated at one portion, may be compared to water flowing through a long tube of small dimensions, and therefore opposing a great amount of friction to the passage of the water. If the tube is indented at any one part, it will decrease the flow to a certain extent; but not nearly so much, as if the bore of the pipe was reduced throughout its length to the same size as it is where indented.

Incidentally connected with, and following as a natural sequence to what has just been said, is the bearing and the value of the resistance opposed by the coils of the telegraph instrument. If an electro-magnet is enveloped with a single convolution of wire, and a battery is connected with it, there will be little resistance to the free passage of the electricity, as owing to the short length of wire, but very little magnetism will be developed. Under such conditions, with a great expenditure of battery-power, a very small equivalent of magnetic force will be obtained. If the number of convolutions be increased, until the resistance opposed by the greater length of wire begins, sensibly, to reduce the dynamic quantity flowing, the magnetic force will then be found to be increased proportionately to the number of convolutions, less certain other considerations, which need not now be entered upon, and with actually less expenditure of battery power. Resistance encountered and overcome, under these conditions, implies so much work done, and the larger the proportion of it in the instruments, relatively to that opposed by the cable, the more economically will the electricity be expended. If the cable is supposed to offer ten times the resistance of that opposed by the coils of the telegraph instrument, which is nearly the case in some printing circuits of 200 miles in length, the whole of the cable, as well as the coils, will be rendered magnetic. Ten-elevenths of the magnetism will be developed in the cable itself, where it will be useless, and one-eleventh only in the coils of the apparatus, where it will be available as a motive force. But if the coil wires are increased in length so as to oppose a resistance equal to 40 miles of the cable, an amount of magnetism equal to one-fifth of that developed in the cable, instead of one-tenth, as in the former instance, will now be developed in the telegraph instrument, if the same quantity of electricity, as in the former case, is forced through. Hence the reason is apparent, why such fine wire, and so great a length of it, is found to answer best for the coils of telegraphic apparatus. In practice there is of course a limit to which the coil wire may be in-

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creased in length, or be diminished in sectional area with advantage.

These are not new facts, for the bearing of the resistance in the coils, to that opposed by the cable itself, is pretty well understood and appreciated by many electricians; but it is believed that attention has not been publicly directed to it before. The remarks which are constantly made show that it is not so well comprehended as it should be. When it was urged upon the projectors of the Atlantic cable, that attenuation at any one portion of the cable would seriously decrease the conducting power of the whole throughout, it was put to the test of a practical experiment; finding it did not perceptibly affect the working, it was accounted for, not for the reasons here given, but from its being at the attenuated portion, a Leyden arrangement of smaller dimensions. This shows that the idea, that reduction at one spot is tantamount to reduction throughout, is entertained by some, whose practical experience deservedly gives weight to their opinions. In the work before alluded to it is said, "The fact is, that this fear of the conducting wire of the cable being telegraphically disabled by attenuation, is based upon the notion that the insulated strand is to act as a *simple conductor*, and not as an *inductively charged Leyden jar.* It may be, and probably is, true that a simple conductor transmits an electrical current with a facility which is in a measure proportioned to its capacity at the smallest part of its length; the entire conductor being virtually reduced in its dimensions to the standard of this smallest part. But it is not true that the transmitting power of an insulated submarine wire, which is virtually a Leyden jar, and open to inductive charges, is modified, from the same cause, to any thing like the same extent. Here the induction, which has taken a mischievous part in producing retardation of electrical movement in coated wires, turns round and makes amends for its interference, by causing small and easily-laid wires to be more manageable for submarime telegraphy than large ones could be."

HEARDER'S PRINTING TELEGRAPH.

As early as the year 1846 an ingenious printing telegraph was contrived by Mr. Hearder, some details respecting which may be of interest to many of our readers. The instrument was not patented, although it appears to have furnished materials for several subsequent patents. Like all step-by-step instruments in which any given letter of the alphabet can be printed only by sending a succession of currents corresponding to the number of letters intermediate between this letter and that last printed, the instrument described below must necessarily be sufficient in point of rapidity of transmission. This objection, however, is, to some extent, removed by the contrivance for moving the alphabetical disc in either direction, *i. e.*, in the direction from *a* to *z*, or from *z* to *a*.

A light metal disc, moved on its axis by a step-by-step action, carries on one of its faces, near the periphery, the letters of the alphabet in Roman characters. Two cylinders, one of which has a coil of paper upon it, and the other of which is intended to wind the coil from the first to itself, are placed in front of the lettered face of the disc. The cylinder upon which the paper is coiled contains a spiral spring upon the principle of a spring roller blind; the other cylinder is advanced, step by step, by means of a rachet actuated by a lever. The moving power is a permanent magnet, mounted, with one of its poles, between the poles of a horse-shoe electro magnet, and maintained in its normal position by means of two slight springs. When a current in a given direction is sent through the coils of the electro magnet the pole of the permanent magnet is attracted to the opposite pole of the temporary magnet; and by this movement the disc carrying the alphabet is advanced one letter. The movement being repeated until the required letter is brought to a given point, the current is then reversed, and the permanent magnet being attracted to the other pole, either actuates a hammer placed behind the paper, or closes a local circuit, which, by means of a second electro magnet, causes the hammer to strike the paper opposite to the letter on the disc, this letter, by means of coloured transfer paper thus making its impression on the sheet. As the hammer drops back into its place, a projecting stud on its prolonged axle moves the lever in connection with the step-by-step action of the empty cylinder, and winds the paper on through the distance of one letter.

The current now being transmitted in the first direction, the letter disc is again advanced by degrees until the next required letter is brought to its position, when the reversal of the current causes it also to be imprinted on the sheet. The hammer, falling back, again advances one step further, and leaves it ready to receive the print of the next letter, and so on until the word is finished. When this is done, the letter disc is moved on until a blank space is brought into position, when the blow of the hammer is again made by reversing the current; but, there being no letter to produce an impression, a space is left after the word.

When a line (say of four inches) is printed upon the paper, a portion of the disc, to which is attached a small lever, is brought into printing position. One end of this lever being now struck by the hammer, the other extremity lifts the driving ratchet of the winding cylinder out of gear, and allows the spring in the first cylinder to recoil and wind back the paper. Both cylinders are loose upon slotted axes, and in their backward rotation advance by a movement similar to that by which the tunes of musical boxes are shifted, so as to allow a second line to be printed below the first.

The apparatus we have described is suitable for a single wire circuit; but the following plan was adopted by Mr. Hearder where two wires were available. The second wire was used exclusively for the printing hammer, and the reverse currents on the first wire were employed to work the disc in an opposite direction. The value of this arrangement is seen in spelling the word *solid*. By the single step-by-step motion in one direction only, after the letter *s* has been indicated, it is necessary to bring up in succession each remaining letter of the alphabet, and then to recommence the alphabet until the letter *o* is brought into position—an operation occupying at least twenty-six movements from *s* to *o*; whereas four movements only suffice by the retrograde action.

ELECTRO-GILDING.

Gilding was formerly performed by amalgamation. A mixture of finely-divided gold and mercury was rubbed over the object, and the mercury afterwards driven off by heat. This process was very detrimental to the health of the workmen, as the fumes of quicksilver are extremely poisonous. It is now almost entirely superseded by the electro-process, which is, in most cases, remarkably easy, and is performed in much the same manner as electro-silvering. The metal to receive the gold may be either platinum, palladium, silver, copper, tin, or indeed almost any other metal, when the auro-cyanide of potassium is employed.

This salt is frequently made by dissolving oxide of gold in a solution of cyanide of potassium. The oxide is prepared by dissolving gold in three parts of hydrochloric acid, and one of nitric acid, which forms the chloride; this is digested with calcined magnesia, and the gold is precipitated as an oxide.

But, as with the silver solution, the best process for preparing the auro-cyanide is by the battery. This is performed by arranging a piece of pure gold as the positive pole in a solution of cyanide of potassium; a porous cell is filled with the same liquid, and then introduced into the bath; a sheet of iron or copper is now placed in the cell in such a position as to face the sheet of gold in the bulk of the solution, and both metals are connected with the battery, as described for making the silver liquid. In fact, there is no difference between the two processes, except that a sheet of gold, instead of one of silver, is placed in the cyanide bath, and that in preparing the gold solution, and for all the operations of gilding by this method, the liquid must be heated to at least 130° Fah. Having made the connections, the battery is allowed to remain in action until the quantity required has been dissolved, which may be ascertained by weighing the gold electrode from time to time, and observing how much it has lost. From one-half to an ounce of gold in the gallon is the common strength of the liquid used in large operations; but a weaker solution is sufficient for gilding small articles.

The articles to be gilt are cleaned in the way described for silver; but as the process of gilding is generally performed upon silver articles, the previous immersion in nitric acid is, in that case, dispensed with. When cleaned and dried they are weighed, and one immersion is given, which merely imparts a blush of gold; they are then taken out, brushed, and re-immersed. If the battery and solution are in good order, three or four minutes will suffice to gild any small article. The hotter the solution, the more rapid the operation, and the less battery power is required. If kept at 130° to 150° Fah., three or four plates may be used; but if raised to 200°, one pair will be sufficient. A convenient mode of applying the heat is to put the jar containing the solution into a vessel of water, which is kept at the boiling point; and as the liquid evaporates by being hot, distilled water must be added after each operation, to prepare it for the following day, as it is not so good to add the water immediately before proceeding to operate. The articles, when gilt, are again weighed, and the quantity of gold deposited is thus ascertained.

Iron, tin, and lead are most frequently gilt by having a slight film of copper deposited on them immediately before being introduced into the auriferous bath. Silver articles, before they are gilt, are merely well brushed, and kept in clean water until they are immersed in the depositing fluid.

The colour of the gold deposited very much depends on the strength of the battery and the temperature of the solution. By due attention to these points any desired shade may be obtained. If the battery is too

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strong, the hue will be black; if the battery is rather weak, and the solution too cold, the coating will be light-coloured. When all the ingredients are properly regulated, the gold, on coming out of the solution, should be of a dark brownish-yellow; and this, when scratched, will yield a beautiful rich deep colour.

To remove gold from articles before regilding, or when the gilding has been performed imperfectly, they may be put into strong nitric acid, to which, when the articles have been immersed, some chloride of sodium is added. This will dissolve off the gold from any metal without injuring the latter; but the mechanical method, by using the lathe-brush, as described for silver, is the best.

When the gold has been dissolved off, it may be recovered by diluting the acid, and then introducing soda or potassa till the acid is nearly neutral; after which a solution of sulphate of iron is added, so long as any precipitate falls by standing. This precipitate is then filtered; the filter, with its contents, is dried, and the precipitate is then fused with a little borax. Oxalic acid may be used instead of copperas with the same results. If the gold be brushed off, the washings are treated as described for silver, and fused with borax.

Electro-platinizing.—This process is similar to the preceding, but is attended with some difficulties. The depositing solution consists of the double chloride of platinum, and an alkali, which must be neutral. Jewrimoff finds that the bath is best prepared in the following way:—One hundred parts of platinum are converted into carefully dried bichloride by treatment with aqua-regia. This salt is dissolved in water, and then one hundred parts of potassa are added. The resulting precipitate is boiled with a solution containing seven hundred parts of oxalic acid. After this has been filtered, three hundred parts of caustic potassa are poured in. The liquid is now well adapted for electro-platinizing in the ordinary way. The object to be operated upon should be smooth, and thoroughly cleansed with an alkali before being introduced into the bath. The cathode must be of platinum, and inserted in the liquid in the manner already indicated for electro-gilding.

Platinum has also been deposited from solutions of its iodide, bromide, and the double chloride of platinum and sodium. The solution of double chloride of platinum and sodium is formed by adding one equivalent—58·5 parts—of common salt to one equivalent—169·7 parts—of bichloride of platinum, and dissolving the mixture in water. The resulting solution requires a very weak battery, and a small anode of platinum to obtain a reguline deposit. A deposit of platinum in the state of a black powder, for platinizing silver plates, may be very easily obtained from it by adding a little sulphuric acid to the solution, and using a much stronger battery and a larger anode.

Electro-palladiating.—For this purpose a solution is prepared by dissolving ammonio-chloride of palladium in liquid ammonia, and the compound battery process employed with a small palladium pole; or palladio-cyanide of potassium may be used for the depositing solution. To form the palladio-cyanide, dissolve some cyanide of potassium in water, immerse a large palladium anode and a small bright cathode of iron or copper in it, and connect them with a small battery of one or two pairs, and continue the action until the cathode receives a good deposit; or, which is better, put the iron cathode in a porous cell, as described for gold and silver. The resulting solution is an excellent one. This metal adheres so firmly to copper, when deposited by this process, that its removal is impossible.

Electro-coppering.—It has been seen that in depositing copper on moulds by the single cell, or the battery process, a solution of sulphate of copper is used; but this solution is not fitted for depositing copper upon iron, steel, or zinc, with a view to adherence, because the electrical relations of these metals are unsuitable to that of the copper in the sulphate, and reduce the copper upon themselves by simple immersion, in which case it does not adhere. The depositing liquid generally employed for covering iron with copper, is a solution of cupro-cyanide of potassium. It is prepared by adding to a solution of sulphate of copper a solution of cyanide of potassa, so long as there is any precipitate formed, but not more, and washing the resulting precipitate until the percolations afford no milkiness with chloride of barium. Great care must be taken not to breathe the gas evolved, which is very poisonous.

Having washed the precipitate, it is dissolved by adding a solution of cyanide of potassium, and then filtered. Four ounces sulphide of copper will make a gallon of solution. This depositing liquid must be worked at a temperature of not less than from 150° to 200°. It forms an exception to the general rule, that if the electricity be so strong as to cause an evolution of gas at the electrode, the metal will be deposited in a granular form, for this depositing liquid will afford no reguline metal unless gas be freely evolved from the surface of the article on which the deposition is taking place. This fact renders necessary the employment of batteries of some intensity. The vessels for this solution are usually of copper, and are heated over a flue, or a sand bath. They then serve as the positive electrode of the battery.

After the iron has been cleansed, an immersion of five minutes is enough to produce upon it a film of copper, but if it is desired that the iron should have a thick coating, and as the cyanide of copper process is an expensive one, it is advisable to increase the coating by means of the single-cell process with a nearly saturated solution of sulphate of copper. The cupreous bath should also be made as neutral as possible, by the addition of a little caustic soda.

Electro-zincing.—The depositing liquid employed for electro-zincing is made by dissolving two pounds of sulphate of zinc in a gallon of water.

To use this solution a separate battery and a zinc positive electrode are necessary. The metal is very readily deposited; but on plumbagoed surfaces, unless great precautions are observed, the metal assumes a crystalline texture, and, therefore, is very brittle. The best way to avoid this is to use a saturated solution of the salt, and to keep the article to be coated in constant motion.

Deposition of Cadmium.—For the electro-deposition of cadmium, the following is the process described in Messrs. Russell and Woolrich's patent, dated March 19th, 1849:—Take cadmium and dissolve it in nitric acid, diluted with five or six times its bulk of water, at a temperature of about 80° or 100° Fah., adding the diluted acid by degrees until the metal is all dissolved. To this solution of cadmium a solution of carbonate of soda—made by dissolving one pound of the ordinary crystals of soda in one gallon of water—is to be added until the cadmium is all precipitated; and the precipitate thus obtained is to be washed four or five times with tepid water; next add as much of a solution of cyanide of potassium as will dissolve the precipitate; after which, one-tenth more of the solution of cyanide of potassium is to be added to form *free* cyanide. The strength of this resulting liquid may vary, but the patentees prefer a solution containing six troy ounces of metal to the gallon. The solution is worked at about 100° Fah., with a plate of cadmium as an anode.

Deposition of Nickel.—Mr. Gore deposited nickel in the state of reguline white metal, from a solution of the double chloride of nickel and ammonia, by making a lump of metallic nickel the anode in a strong aqueous solution of hydrochlorate of ammonia—sal ammoniac—and passing a strong current of electricity through it for several hours, as described for gold and silver, until the liquid acquired a pale greenish-blue colour; also by treating a solution of one part of arseniate of potash and five parts water in a similar manner. Nickel is likewise deposited from a solution formed by dissolving the pure metal in nitric acid, then precipitating it either by a solution of caustic potassa, carbonate of potassa, or cyanide of potassium; washing the precipitate, and dissolving it in a solution of potassium, and operating by means of a battery and an anode of pure nickel. Its appearance, when deposited from this solution, is said to be nearly equal in whiteness to silver, and its deposition has been proposed to be applied to the production of an inferior class of plated articles.

Deposition of Iron, Tin, and Lead.—Iron and tin are easily deposited, the former from its sulphate solution, the latter from its proto-chloride; and lead may be deposited either from its acid or alkaline solution, but with greater difficulty. No practical value has yet been attached to the deposition of these metals.

Deposition of Antimony.—Next to copper, antimony is one of the most easy metals to deposit in a coherent state, but does not spread over black-leaded gutta percha surfaces, nor does it adhere with any degree of firmness when deposited upon copper, brass, or iron; nor has the deposition of it been yet applied to any useful purpose, although bright deposits of considerable thickness may easily be obtained. The deposited metal, also, exhibits in certain circumstances very remarkable phenomena, which render it worthy of notice. It is readily deposited from a solution of the ordinary chloride of antimony—butter of antimony—as prepared for pharmaceutical purposes, by suspending a small piece of antimony as an anode, and using a very weak battery of one, or at most, two pairs. The mixed chlorides of antimony and ammonia form also an excellent depositing liquid. The appearance of antimony, when deposited from any of the chloride solutions by a weak and continuous current, is very brilliant, similar to highly-polished steel. The remarkable properties to which allusion has been made, appear when it is deposited rather rapidly, and seem to have been first observed by Mr. Gore, by whom they were described in the *Philosophical Magazine* for January, 1855, in the following terms:—If, during any part of the time, the deposit is progressing, the deposited antimony to be taken out and struck gently or rubbed with any hard substance, such as metal or glass, an explosion occurs, with a small cloud of white vapour, sometimes with a flash of light, and nearly always with considerable heat, sufficient to burn one's fingers, melt gutta percha, burn paper, and even scorch deal wood quite brown, especially if the deposit is thick: and invariably accompanied by fracture of the deposited metal; sometimes, if the process of deposition has been interrupted, and the deposited metal is not homogeneous, only a thin scale falls off—in such cases the heat and explosion are less; in other instances, where the process was regular and the metal homogeneous, the fracture extended quite through the metal to upwards of one-eighth of an inch in depth. He observed this phenomenon in about nine instances, in several of which the explosion took place even in the liquid, by striking the deposit against the glass containing vessel; and in one instance it occurred after the metal had been well washed with dilute hydrochloric acid, dried, and had remained out of the liquid several hours.

Since publishing these observations, Mr. Gore writes in the *Pharmaceutical Journal*, that he has met with the same phenomenon many times, and in several instances a deposit has been going on in the chloride solution, and has been removed an instant for examination, and the battery power—one cell of Smee's—has been increased by addition of acid, and upon the next examination some hours afterwards, the deposit has been found cracked in many directions, as if a feeble explosion had occurred in the interval, the apparatus being meanwhile unmoved. It has been sug-

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gested that the deposit is a compound of antimony and hydrogen, and this idea is favoured by the observation, that when the metal is deposited very slowly indeed the explosions do not occur, and that in every case where an explosion took place the metal had been deposited more rapidly —the extra power probably depositing hydrogen also; which, instead of being as usual evolved, might, in its nascent state, combine with the metal and form an explosive compound. Mr. Gore hazards the additional suggestion, that the metal is deposited in a peculiar structural condition—a state of unequal mechanical tension, similar to that of unannealed glass, and that when broken, the closer aggregation of the particles develops heat and light.

Another peculiarity in the deposition of antimony from the chloride is, that if the cathode be sustained, partly in the liquid, and kept uniformly at that depth without disturbance, a deposit of the metal will occur upon it at the surface of the liquid, and spread out gradually in the form of a thin button all around—if it be a wire—and ultimately touch the anode if sufficiently near, lying as a circular sheet of metal upon the surface of the liquid, whilst the deposit beneath progresses very slowly. He has a button one inch and five-eighths in diameter, and one-sixteenth of an inch thick, formed in this way upon a piece of wire three-sixteenths of an inch thick, the part of deposit beneath the surface of the liquid being only half an inch in diameter. The battery used was a one-pair Smee's, and the process occupied about eighteen days.

Deposition of Bismuth.—Bismuth is easily deposited from a solution formed by dissolving either the nitrate or subnitrate of the metal in a mixture of nitric acid and water. It requires a much weaker current even than antimony to deposit in a bright coherent state. Its appearance, when slowly deposited, is a very beautiful white, with a faint pinkish tint, and having a fine silky lustre.

Deposition of Brass and other Alloys.—The attempts that have been made to deposit alloys from their solutions, have not been attended with much success hitherto; but a process for depositing brass, patented by Moriss and Johnson in 1852, is said to be productive of good results. This process is as follows:—Dissolve one pound of cyanide of potassium, one pound of commercial carbonate of ammonia, two ounces of cyanide of copper, and one ounce of cyanide of zinc, in one gallon of water; and use the solution at 150° Fah., with a large anode of brass and a powerful battery; or a solution may be taken of one pound of cyanide of potassium and one pound of carbonate of ammonia, dissolved in one gallon of water, and saturated with copper and zinc by means of a strong battery, with large brass anode and small cathode, until the latter receives a good deposit of brass, the solution being at about 150° Fah. To increase the proportion of copper in the deposit, either add cyanide of potassium, or raise the temperature of the liquid; and to increase the proportion of zinc in it, either add carbonate of ammonia, or lower the temperature. Always use a large brass anode.

Mr. Gore states that of the different solutions for depositing brass which he has tried, the above is much the best, as by it reguline and thick deposits of brass of uniform colour, and of any desired composition, may be obtained.

Steele's mode is to dissolve separately two and one-quarter pounds of American potassa, and two and a-half ounces of powdered acetate of copper, previously mixed with half a pint of strong ammonia, four of five ounces of sulphate of zinc, and cyanide of potassium, two ounces; these are to be added to six gallons of warm distilled water. Walker states that he tried this solution, but did not succeed.

The following solution of different metals is given on respectable authority as yielding a good bronze-coloured deposit:—

Carbonate of potassa	50 parts.
Chloride of copper	2 „
Sulphate of zinc	4 „
Nitrate of ammonia	25 „

In operating with this liquid a brass plate is directed to be used as the positive electrode.—*Dr. Muspratt's Chemistry.*

THE COLONY OF SOUTH AUSTRALIA.

Electric Telegraphs.

Like the railways, our electric telegraph is wholly in the hands of the local government, as also are the lines in the neighbouring colonies. As a medium of communication, the electric telegraph is eminently adapted to meet the circumstances and wants of a young and sparsely-peopled colony, with its small but rapidly rising townships scattered over a great area. New ones are continually springing into existence, as the enterprise of man discovers new fields of industry, and these possessing necessarily, as compared with the Old Country, indifferent means of intercourse, we may account for the rapid extension of the telegraphic system in Australia.

This department is under the direction of Mr. Charles Todd, M.B.M.S., late Superintendent of the Galvanic Department, and Assistant Astronomer at the Royal Observatory, Greenwich. Mr. Todd was sent out by the Home Government in 1855; and early in the following year the first line was opened, connecting the port and sea coast with Adelaide. This line is about ten miles in length, and has four wires as far as the port. Until recently it was worked on Henley's magnetic system, employing two needles; but last year the needle instruments were displaced by Morse's Recording Telegraph, using, however, permanent magnets in place of line voltaic batteries. In April, 1857, another line was opened to Gawler Town, twenty-six miles, worked also with magnetic electricity; and during the same year, communication was established with Goolwa, a rising port near the mouth of the Murray, about fifty-five miles from Adelaide—Morse's system being then introduced, to conform with the lines in Victoria.

In 1856, Mr. Todd having laid before the Government a scheme for connecting South Australia with Victoria and New South Wales, was dispatched to Melbourne to make the necessary negociations, and returned overland to fix the route of the proposed line. At this time, the only lines at work in Victoria were one to Geelong and Port Philip Heads, and another short line to Sandridge. In New South Wales they had not yet introduced the telegraph.

Telegraphic communication was established between Adelaide and Melbourne—about 700 miles—in July, 1858, and with Sydney in November of the same year. It now reaches Brisbane, the capital of the new colony of Queensland. Since then, lines in South Australia have been extended in the north as far as Kooringa, the site of the celebrated Burra Burra Copper Mines—including Kapunda, a mining town of considerable importance, and Clare. Also to Mount Barker and Strathalbyn, from which place a second intercolonial line to Victoria has been erected; and lines are being carried to Wallaroo and Yorke's Peninsula, to Yankalilla, and from Mount Gambier to Mac Donnell Bay, near to Cape Northumberland.

The following statement will serve to show the extent to which the telegraph was used during the year 1861, with about 1,000 miles of wire:—76,709 messages were transmitted, yielding a revenue to South Australia of £7,382 9s. 8d., and £3,792 6s. 1d. to Victoria and New South Wales; or a total of £11,174 15s. 9d. There are nearly 4,000 miles of line in operation in Australia at the present time, and the success which has attended the recent attempts of Stuart and Burke to cross the Australian Continent, induces the belief that, within a few years, we shall have a line from Adelaide to the Northern Coast, in the neighbourhood of Cambridge Gulf. Indeed, Mr. Todd, some two years back, submitted to the Government an estimate of the cost of such a line, which he sets down at £200,000. He proposes that a company should be invited to meet us with a cable, to connect the north end of the land line with Java and the Indian telegraphs; so that on the restoration of the Red Sea line, telegraphic communication should be established between Australia and England. The observatory is conjoined to the Telegraph Department, but the astronomical portion has not yet been erected; meteorological observations are, however, carried on at the Observatory, and also at many of the Telegraph Stations, each of which furnishes a daily weather report, including the height of the barometer, the temperature of the air and evaporation, direction and force of wind, amount of rain, &c.

Telegraph Stations are erected in various parts of the colony, wherever the telegraph lines have been conveyed. They are generally commodious buildings, in the Italian style, and have cost from £700 to £100. A Head Station in Adelaide is in contemplation.—*From "An Account of the Colony of South Australia." By Frederick Sinnett.*

ON THE ALLOTROPIC STATES OF OXYGEN, AND "NITRIFICATION."

The direct combination of nitrogen with either hydrogen or oxygen, to form ammonia or nitric acid, is a problem of the highest interest in the point of view as chemical science, and of immence practical importance, to agriculture and manufactures.

In France, during the time of the first Napoleon, *nitrification*, the artificial formation of nitre was looked upon as a matter of the greatest national moment; and in time of war supplies of nitre have occasionally been raised by a compulsory tax upon certain districts, to be met only by the adoption of certain processes of nitrification. But cheap ammonia or cheap nitric acid means also luxuriant vegetation at a cheap rate; these substances, with the compounds of phosphoric acid, constituting the active agents of manures.

From the recent researches of Schönbein, embodied in the following extract from a letter addressed to Professor Faraday, it appears that the evaporation of water in air is always attended with the formation of the nitrite of ammonia. The elements of three equivalents of

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water combine with two equivalent of atmospheric nitrogen, forming—

$$NO_3.NH_3$$

or nitrite of ammonia. It is probable that the formation of this compound on an extended scale may ere long be found practicable, a result which would far surpass in importance any of the attempted transmutations of the alchemists of old:—

"I have been busily occupied with my favourite study, and have found out several new facts regarding the allotropic states of oxygen, their changeability one into another, and nitrification, and I am inclined to believe that the results obtained are not quite void of scientific interest.

"After many fruitless attempts at isolating ozone from an 'ozonide,' I have at last succeeded in performing that exploit; and have also found out simple tests for distinguishing with the greatest ease ozone from its antipode, 'antozone.' As to the production of ozone by purely chemical means, the whole secret consists in dissolving pure manganate of potash in pure oil of vitriol and introducing into the green solution pure peroxide of barium, when ozone mixed with common oxygen will make its appearance, as you may easily perceive by your nose and other tests. By means of the ozone so prepared, I have rapidly oxydized silver at the temperature of —20° C., and by inhaling it produced a capital 'catarrh.'

"Regarding nitrification, the most important fact I have discovered is the generation of nitrite of ammonia out of water and nitrogen, *i.e.*, atmospheric air, which is certainly a most wonderful and wholly unexpected thing. To state the fact in the most general manner, it may be said that the salt mentioned is always produced if water be evaporated in contact with atmospheric air. This may be shown in a variety of ways. Let, for instance, a piece of clean linen drenched with distilled water dry in the open air, moisten it then with pure water, and you will find that the liquid wrung out of the linen and acidulated with dilute sulphuric acid (chemically pure) will strike a blue colour with starch-paste containing iodide of potassium, by the by, the most delicate test for the nitrites. It is, therefore, a matter of course that shirts, handkerchiefs, table-cloths, in fact all linen, &c., must contain appreciable quantities of nitrite of ammonia; and if the chemistry of England be not entirely different from that of Switzerland, you will find the same thing at the Royal Institution. The purest water, suffered to evaporate spontaneously in the open air, will after some time have taken up enough nitrite of ammonia (continually being formed at the evaporating surface) to produce the nitrite reaction. If you make use of water holding a little potash, or any other alkali, in solution, the same result will be obtained, *i.e.*, the nitrite of that base will be formed (of course in small quantity). The most conveniedt way of performing the experiment is to moisten a bit of filtering-paper with a dilute solution of chemically pure potash, &c., and to suspend it for twenty-four hours in the open air. On examining the paper it will be found to contain a perceptible quantity of a nitrite, which by a longer exposure of course increases. But you may still more rapidly convince yourself of the correctness of my statements, if you heat pure water to a temperature of 50° or 60° C. in a porcelain basin, and suspend over the evaporating surface bands of filtering-paper soaked with a weak solution of potash, soda, or the carbonates of these bases. Within a very short time (in ten minutes or so) there will be enough of the nitrite accumulated in the paper to produce the reactions of that salt. I enclose a bit of paper treated in that way for a couple of hours, and by laying it upon a watch-glass and pouring over it acidulated starch-paste containing iodide of potassium, you will perceive the effect produced. The fact which I have ascertained, that the purest water mixed with a little chemically pure sulphuric acid or potash and kept for some time evaporating in the open air at a temperature of 50° or 60° C. (the loss of the liquid being now and then restored) contains, in the first case, a perceptible quantity of ammonia, and, in the second case, of nitrous acid, may now be easily accounted for. You know that about eighteen months ago I found that, during the slow combustion of phosphorus in moist atmospheric air, very perceptible quantities of nitrite of ammonia are formed, and drew from that fact the inference that the salt is engendered by 3 equivalents of water combining directly with 2 equivalents of nitrogen. Now there is to me hardly any doubt that the production of that nitrite is due to the evaporation of water taking place about the phosphorus, whose temperature, in consequence of its burning state, proves to be higher than that of the surrounding medium, and the fact alluded to must, therefore, be considered only as a particular case of a general rule. The same remark applies to the formation of nitrite of ammonia which takes place during the rapid combustion of charcoal, &c., in atmospheric air. Combustion, as such, has, I believe, nothing to do with that formation. I must not omit to tell you that by means of a large copper still, properly heated, and taking care not to introduce too much water into the vessel at once, I can prepare in a very short time several pints of water with which the reactions of nitrite of ammonia may be produced in the most striking manner. I hope before long to have an opportunity of sending you some of this water.

"I cannot finish my letter without saying a word or two about nitrification in general, a fact hitherto so much enveloped in obscurity. I think the matter is now clear enough. The evaporation of water is continually going on in the atmosphere, and along with it the generation of nitrite of ammonia. Now, this salt being put in contact with the alkaline bases or their carbonates, nitrites of potash and the other alkalies are formed, which afterwards become gradually oxydized into nitrites. In our rainy countries these salts are washed away almost as soon as formed, and carried into the springs, rivers, &c.; and there is, therefore, no accumulation of them as in the East Indies, &c.

"That the formation of our nitrite out of water and nitrogen is a fact highly important for vegetation need hardly be stated. Indeed, each plant, by continually evaporating water into the atmosphere, becomes a generator of nitrite of ammonia, preparing, if not all, at least part of its nitrogenous food, and the same thing takes place in the ground on which it stands. I am, therefore, inclined to thank that our friend Liebig is right in asserting that no plant wants any artificial supply of ammonia, or of matters producing that compound, there being enough of it offered by natural means. Having communicated the results of my researches on the subjects mentioned above to the Academy of Munich, I hope they will soon be published.

"[In relation to the peculiar circumstances under which the oxygen and nitrogen combine, it may be worth while here to refer to the results obtained by Dr. Bence Jones (*Phil. Trans.* 1851, p. 407, &c.), where the direct union of these gases in all cases of combustion in air is described. Schönbein's results depend upon evaporation. —M. F.]"

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

Para, a parcel of fine has been sold at ... 1s. 9½d. per lb.
Java fine ... ... 1s. 4d. to 1s. 5d. „

GUTTA PERCHA.

Fine ... ... 2s. 6d. per lb.
A sale of genuine mixed at ... ... 1s. 11d. „
Ordinary reboiled ... ... 9d. to 10d. „

July 24, 1862. WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	100	48 to 52	——
20	Do. B 7 per cent. till 1862 .	all	18 to 20	——
20	Do. C. „ „	all	9 to 11	——
10	London & S. of Ireland Direct.	2	— —	——
Stock	Electric Telegraph . .	100	100 to 103	102½
5	London District Telegraph .	4¾	3¾ to 3¼ dis.	——
10	Mediterranean Extension Tel.	all	3 to 4	3⅝ to ½
20	Red Sea and India Telegraph	all	19½ to 20½	——
1	Submarine Telegraph, scrip.	all	⅜ to ⅝	——
1	Do. registered . . .	all	⅜ to ⅝	——
10	Do. „ . . .	all	4 to 6	——
2	Telegraph to India . .	1	⅝ to ⅜ dis.	——
5	United Kingdom Telegraph .	3	1½ to ½ dis.	——

Colonial and Foreign Telegraphy.

TELEGRAPHS.

CONSIDERABLE progress has been made with the telegraphic extensions recently commenced under the votes of Parliament last session.

On the extension from Campbelltown to Wollongong and Kiama, the line has been cleared as far as the bottom of the Bulli Pass, seven miles from Wollongong, and poles have been erected nearly the whole of that

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distance; the stretching of the wire has been commenced. It is expected that the wire will be carried into Wollongong in the course of a week.

Upon the extension from Tenterfield to Grafton, the line has been cleared for about fourteen miles, and the poles erected for a distance of eight miles. The length of the extension is 123 miles, and it is to be finished in four months.

About twenty-five miles of clearing has been done on the line between Mudgee and Wellington. The holes are sunk for twenty-five miles, and the posts are up for a distance of fifteen miles, but none of the wire is yet stretched.

The longest of the new lines—that between Orange and Wagga Wagga —a length of 260 miles—has been commenced, but little progress has yet been made.

A second wire has been stretched between Muswellbrook and Scone, and a station was opened at the post office at the latter town last week; messages between these places being transmitted by means of Wheatstone's alphabetical instruments.

Two years since, a second wire was stretched between Sydney and Albury, on the promise of the then Government of Victoria, that a second wire should be carried through to Melbourne. The performance of that promise has been repeatedly postponed; but a contract has at length been taken for the additional wire, the completion of which will give increased facilities for communication between the two colonies.

Upon the execution of the contracts now in progress, there will be 2,500 miles of wire stretched throughout the colony. The new lines have afforded great advantages to the localities which they have connected with the metropolis, but owing to the extension to distant and thinly populated districts, the per centage of profit yielded by the Telegraph Department has been thereby considerably diminished, and as all the principal centres of business in the colony will shortly have telegraphic communication, it is not expected that the Government will place on the estimates this year sums for further extension.—*Sydney Morning Herald.*

The South Australian Government are likely to abandon, after the arrival of the April mail from England, the branch service they at present maintain between Adelaide and King George's Sound. The other colonies obtain, on the average, by means of this service, a summary of the news twelve hours earlier than they would do if the ocean mail steamer was not so intercepted at King George's Sound. The proposal to abandon the branch service has revived a proposition to extend a line of telegraph from Adelaide to Albany. Great difficulties would no doubt be encountered in forming and maintaining such a line, and the position of the telegraph operators in the intermediate stations, along the desert coast of the Australian bight, would be unpleasant enough; but such a line would bring the whole of the Australasian colonies six days nearer England, and would be of great consequence when the telegraph is extended from the Red Sea to Galle. Meantime the electric wire has been extended to Brisbane, in Queensland, which is now in direct electric communication with Sydney, Melbourne, and Adelaide; and it is in contemplation to form a settlement at Cape York, on Torres Straits, to which, doubtless, the wire will be carried before long. Communication by telegraph with England, by way of Timor, the Dutch settlements, Singapore, and Calcutta, would then be an easy matter, and one of time, not of experiment.—*Melbourne Argus, May* 24, 1862.

Telegraphic News.

A deputation of the directors of the Telegraph to India Company waited by appointment on Friday last upon his Highness the Pasha of Egypt, on board his Highness's yacht, Faid Gehaad, to acknowledge the courtesy and cordial co-operation which had been extended by his Highness to the Telegraph to India Company in the prosecution of their operation in Egypt and the Red Sea.

The Chairman explained the object of the deputation:—To acknowledge and thank his Highness for the uniform and active assistance and support which had been so liberally extended to the company during their operations; to express the high sense entertained of his Highness's liberal and enlightened policy in encouraging such public works as were calculated to benefit the country, and to extend civilization by the increased facilities of intercourse between the East and the West; to assure his Highness of the company's readiness to co-operate in any measure for furthering these important objects; and to inform his Highness that, although their operations had not been successful as regarded the repairs of the eastern division of the line, the precise and positive information obtained was of the highest value for future guidance in prosecuting the object in view.

His Highness expressed himself much gratified to receive from the deputation the assurance of the approval of those measures which, in the great interests of the world at large, he had sanctioned and assisted. A liberal, and he believed a just and judicious policy, had guided his Highness in his decision on these matters; and with reference to the views of the Telegraph Company relative to the further prosecution of their important undertaking, his Highness expressed his readiness to receive any proposition from the directors, which they might rely would receive his Highness's best consideration, and, if consistent with the public interests, his cordial concurrence and support.

At the conclusion of the interview, the Chairman mentioned that about a quarter of a century since, he had been engaged, with others, in constructing the largest cannon and mortars probably in the world for his Highness's father, Mehemet Ali Pasha, and it was a more grateful and agreeable service to be engaged in discussing with his Highness measures so much better calculated to extend the good understanding and to identify and cement the common interests of mankind.

The deputation (consisting of Sir Macdonald Stephenson, the chairman of the company; Mr. P. P. Blyth, Mr. William Dent, Mr. F. C. Gaussen, Captain Hall, R.N., C.B., and Mr. Alexander Wilson, directors; Sir Charles Bright and Mr. Latimer Clark, the engineers of the company; and Mr. C. L. Peel, the secretary) was introduced by Mr. Larking.

The English steamer *Bahiana* arrived here on the 4th with telegraphic cable on board belonging to Messrs. Newall and Co., intended to repair the different sections connecting Gallipoli with the Dardanelles, Syria, Smyrna, Scio, and Candia, all, or nearly all of which lay in very deep water, having stopped working within the last three years. The failure of the Gallipoli portion, only a few months ago, caused all messages for the Archipelago to be sent on by post. The *Bahiana* left on the 5th for Scio.—*Malta Times, July* 10.

The International and Electric Telegraph Company is about to lay a cable from the Ness Point to the Coast of Holland, and men are now engaged in laying down pipes to carry the wire from Lowestoft telegraph office to Ness Point.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

JURORS' AWARDS IN CLASS XIII.

To the Editor of The Electrician.

Sir,—The International Exhibition is esteemed, by not a few individuals, a huge failure. I do not indorse this opinion, but every thinking person must admit there are only too good grounds for it in some respects. There is the building itself, the exterior of which is about on a par with a Puritan meeting-house in the time of the Commonwealth, surmounted by a pair of gigantic bubbles, looking as if they had just fallen fresh from the clouds, and were now in process of evaporation. Fortunately the interior belies the exterior. To institute comparisons between it and its predecessor of '51 is simply to saw unnecessarily on an already worn-out string; still I may be allowed to say that its general internal arrangements are as far behind those of the fairy palace above mentioned as is its outward appearance. The superiority of the second to the first edition lies in the accumulated emulative excellencies of its enterprising and noble-spirited exhibitors. So much for appearances, which are here referred to as a fitting and characteristic introduction to the more immediate object of this letter.

The Exhibition, like all other things, has its red-letter days; and Friday, the eleventh instant, was one of the most important thereof, inasmuch as every tub was then supposed to stand upon its own bottom, and the exhibitors to have honours awarded or not in accordance with their desserts, irrespective of who or what they were, or what influence they might chance to possess with the jurors.

Respecting the appointment of the jurors, a great many simple-minded persons had the impression that these gentlemen would be chosen from the large mass of experienced and competent individuals who were not themselves exhibitors; and the writer hereof happens to know more than one instance where gentlemen honourably declined being put in nomination, considering that the two positions were incompatible; but it is not every one that has these delicate scruples, as the sequel will show.

Certainly the Commissions should have made it a *sine qua non* that no exhibitor should be chosen as a juror, neither for the class in which he exhibited, nor any other—the former case in particular, seeing it was certain to lead to the worst of abuses—unfairness and partiality; as self interest, prejudice, and foregone conclusions must necessarily cloud the judgment. There are cases in this present distribution of honours, where the *jurors being exhibitors, have been awarded medals*, which is something similar to an epicure presenting his honourable self with a testimonial for the extreme and fostering care he has taken of his own carcase; in other cases the business has been done less unblushingly, persons have been presented with medals, not upon their own merits, but as proxies of the exhibiting jurors. Of course it looks egotistical to make presents to ones self, and is repulsive to some peoples' virtue, at least that side of it they show to the world.

It is with Class 13, however, that we have to do, as containing all that is exhibited in electrical and telegraphic matters. And here I would be glad to be informed why telegraphy and all thereto appertaining were not

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formed into a distinct and separate class, and so have had the whole body of jurors for the class selected from the numerous eminent electricians and telegraph engineers, who have a thorough knowledge of the matters they would have been called upon to decide.

Is telegraphy such an insignificant affair as to be fit only to be classed with instruments for displaying the conformation of a bee's knee, defining the constitution of a semibreve, showing the variations in the swinging of a pendulum, or how much grinding it will require to produce an electrical spark of a given length? Hitherto I had thought that telegraphy was the most important enterprise of the age, a science in its infancy it is true, but destined to become the mightiest operative agent for the benefit of humanity the wide world over; and as such, that it required the most careful development, that nothing should militate against the due appreciation of its advancement, and, in order to secure these ends, that due prominence and patronage should be given and extended to every effort made for its advancement when worthy. But how can this be done when it is "cribbed, cabined, and confined" as a trifling addendum to the philosophical department, and that, too, at the world's exhibition, This scurvy treatment has now produced its legitimate fruits. Out of seventeen jurors and assistant jurors, or experts (don't be alarmed Doctor, this word has been re-coined at the Mint), there are three only possessing any practical acquaintance with electrical and telegraphic science; to make up for this, however, there are ten Fellows of the Royal Society; there's a weight to throw in the scale. Doubtless Her Majesty's Commissioners were duly impressed with mysterious awe when they hove in sight of these philosophical matters, and thought they could not do better than see that they were handed over in the lump to the grappling erudition of half-a-score F.R.S.; for gentlemen with this talismanic tail to their names are supposed to be on very intimate terms with the most abstruse affairs, both in heaven and earth, and under the earth; specially if they are Professors also, and can double and treble their erudite tails with LL.D. and such like. I know I should shrivel up like a parched scroll in the presence of these august philosophers, and yet I venture to say "there are more things in the earth (to say nothing about heaven) than is dreamed of in their philosophy." And I am audacious enough to believe that the magic string of Roman characters at the end of their names does not endow them with a knowledge of telegraphy, whatever else it may do.

In all the other classes men were chosen as jurors who were more or less conversant with the nature of the articles therein exhibited; and although, in some cases, there has not been that impartial and cosmopolitan spirit manifested that could be desired, still it cannot be said that incompetent persons were chosen. But here, in Class 13, only a sixth part of the persons were at all acquainted with the articles to be subjected to their adjudication, so far as the most important part of that class is concerned. And now suppose we examine the eligibility of the three gentlemen who did know all about that part of the class.

Professor Thompson is well up in electrical and telegraphic science, in fact, he may be said to know something about it, there is no mistake about that, and I humbly sink into my shoes in his presence. Professor Thompson also knows how it was that the Magnetic Telegraph Company were awarded a medal for an electro-magnetic clock which has never kept a day's correct time since it has been in the Exhibition, while Mr. Henley's clock of the same description, one of the most correct and exquisite pieces of workmanship in the Exhibition, was passed over in silence. Another eminent Professor also could throw some light on this matter if he chose. The juror in question receives his medal per his proxy, Mr. White. White may keep the medal of course, but the glory is the Professor's.

Professor Wheatstone is also a first-rate electrician, and eminently fitted for a juror, had he not been an exhibitor, and, moreover, possessed of certain prejudices and partial leanings which render him totally unsuitable. How was it possible for him to act with fairness and impartiality, when, in addition to his being an exhibitor in the same class, he is in litigation with two of his fellow exhibitors—Henley, of London, and Wilde, of Manchester—for alleged infringements of his patents, besides being notoriously interested in the adoption of another exhibitor's method of insulation, &c.? We know that litigious processes are invariably pursued with a rancour and bitterness that not unfrequently pushes one or both of the litigants to the verge of ruin, and, of course, the feeling manifested is the opposite of friendliness and cordiality. Neither Mr. Henley nor Mr. Wilde can be surprised, therefore, that the jurors were sublimely unconscious of the presence of their inimitable galvanometers, &c.; nevertheless, all the world knows that these instruments are second to none in the Exhibition; indeed, I know there is one by Henley immeasurably superior to anything exhibited by the proxies of any Professor.

Mr. Fleeming Jenkin, "Associate Juror, or Expert," can only be considered a make-weight, to save appearances; in saying this, I mean nothing derogatory to his electrical knowledge; neither do I believe he would consciously lend himself to become a toady to anyone; unwittingly, however, he is just what I have said, neither more nor less.

Mr. Wilde, of course, was not so wild as to expect any notice taken of his Alphabetical Telegraph. Mr. Henley probably was, because he was fully conscious, as he had a right to be, of the superior excellence of his instruments. For all these excellencies, however, he is munificently snubbed; and to keep down his bile, is honourably mentioned "for the successful manufacture of his telegraph cables."

Mr. Allan gets a medal after this wise:—Professor Wheatstone exhibits an Automatic Telegraph; Mr. Allan also exhibits a similar instrument; both are excellent; but care must be taken, in awarding a medal to Mr. Allan, that his instrument do not appear the more excellent of the two, and so throw the exhibiting juror's into the shade. Mark the cleverness of the arrangement; Mr. Allan does not receive a medal for the general excellence of his instrument, which would have been only *comme il faut*, but for the ingenuity manifested in a comparatively unimportant part thereof. As though I should say, "Brown, your clock is a good one, and so is mine; I don't care about any glorification; still, I don't want the world to think yours is the better one; so I'll just get you a medal for your elaborate ornamentation, and leave the comparative excellence of the general construction an open question."

Messrs. Glass, Elliot, and Co. are awarded a medal for the successful application of their electric telegraph cables; the award *may* be merited; but the public ought to know by this time if the word "successful" be appropriate: if it be meant, as compared with others, it cannot be gainsaid, since they have had it all pretty well to themselves. The same remarks fit precisely the case of the Gutta Percha Company, who are also decorated with a medal, which will probably be of service to them in an advertizing point of view.

Messrs. Siemens, Halske, and Co. are similarly glorified, for the "general excellence" of a "telegraphic apparatus" that will never be of any earthly use, it being something like the coat which Truffles, the tailor, patented for buttoning up behind. The writer hereof might have exhibited an ingenious pair of wings, by means of which you might take an occasional trip to the moon; but I would not guarantee its efficiency.

These gentlemen emerge from the proceedings of the 11th instant, loaded with honours and medals, and may strut before the scientific world with as many decorations in their breasts as Peninsular and Waterloo veterans. You may depend upon it, it's a fine thing to be located in the West—the precincts of the potential world.

Messrs. S. W. Silver and Co. are also beatified for the general excellence of their caoutchouc insulated conductors. Could their friend and patron Cornlapis do less? and yet, Messrs. Wells and Hall, who have been honoured by Her Majesty's Government and the Indian Board with several orders for their India rubber covered wires, revel in the luxury of an "honourable mention." Messrs. Wells and Hall must, per force, be content with the same liberal award as that which gladdens the heart of Mr. Henley; but, is their no credit due to them for the silk covered wires exhibited, some of which are finer than the finest hair on my lady's pretty head? not a bit of it; it is quite a common-place affair to cover a copper wire with silk measuring over nine miles to the pound, and so the jurors passed it over as a mere bagatelle. I had purposed saying something about the submarine cables exhibited, but must reserve it for another letter; suffice it to say that they were very coolly ignored.

After all these specimens, it is not likely Mr. Tyer would fall into hysterics because the jurors, from their lofty eminence, could see nothing in his ingenious and practical "Train Signalling Telegraphs," than which nothing in the Exhibition is more worthy of commendation and honourable award.

Of course, the other fourteen "jurors, assistant jurors, or experts," were simply led by the nose by the other three, and, therefore, can be scarcely held responsible for these specimens of juridical fairness. But since the telegraph portion of Class 13 is the most important part, why were not at least one-half the jurors electricians and telegraph engineers? It is discreditable that it was not so, and a slight, if not an insult, to such eminent men as Sir William O'S. Brooke, Captain Galton, Mr. Fairbairn, and half-a-dozen others whom I need not name.

July 18th, 1862. MOMUS.

To the Editor of THE ELECTRICIAN.

SIR,—Will you, or some of your talented correspondents, kindly favour me with practical answers to the following questions?

1. What are the means usually adopted for polishing ebonite? I have a disc of this material, but it is polished only on one side, as though intended for an electrophorus, and I wish to polish the other side, so as to use it for an electrical machine. I have tried the finest sand paper I could procure, but that has not the desired effect.

2. What are the prices per square foot of ebonite, varying in thickness from $\frac{1}{4}$ to $\frac{1}{2}$-inch? I think this material would be far preferable to wood in the construction of some portions of electrical apparata, if equally cheap.

3. In preparing the auro-cyanide for electro-gilding, Dr. Muspratt says, "The oxide is prepared by dissolving gold in three parts of hydrochloric acid, and one of nitric acid, which forms the chloride; this is digested with calcined magnesia, and the gold is precipitated as an oxide." Can you please inform me what quantity of magnesia should be used per ounce of chloride to produce the oxide as above; or if this has not yet been experimentally determined, what means should be adopted for separating the insoluble magnesia from the insoluble oxide of gold, supposing the magnesia to be used in excess; or is such separation necessary—that is, will the cyanide of potassium dissolve only the oxide of gold, leaving the excess of magnesia to be collected by filtration?

4. Among the numerous forms of battery elements, where large quan-

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tity and tolerable tension is required, there is, probably, no combination that would meet the requirements of a student better, in an economic point of view, than that in which gas-carbon forms the negative in the nitric acid battery. The principal difficulty, so far as I can understand, opposed to the general use of this substance, appears to rest in the amount of labour required to reduce it from the unsightly masses in which it is usually produced, to sheets suitable for battery purposes. To accomplish this by mere hand labour would no doubt prove very costly and unremunerative; but I think a tool, made similar to what is generally termed a "disc machine," would effect the purpose admirably, and at a low cost. This machine consists of a simple disc of thin sheet iron, made by means of suitable wheels to revolve with extreme rapidity. One which was exhibited at the Panopticon some few years ago, would readily cut a hardened steel file in two without apparent injury to the disc. Judging from the price at which gas-carbon is usually sold when reduced to sheets, I think the construction of such a machine, if for this purpose alone, would prove a profitable speculation to anyone who happens to have steam power at command. Query: Do you think, from your experience, that if the cost could be reduced, say 50 per cent., the demand would be equal to the supply which one machine would give?

Trusting I have not encroached too far upon your valuable space,—I am, dear sir, yours respectfully, KRU.

JURORS OF THE INTERNATIONAL EXHIBITION.

To the Editor of THE ELECTRICIAN.

SIR,—In page VI. of the Commissioners' Report of the Award of Medals and Honourable mention, &c., will be found the following notice:—

"5. If Exhibitors accept the office of Jurors or Associate Jurors or Experts, they cease to be competitors for prizes in the *Class* to which they are appointed, and these cannot be awarded either to them *individually* or to the *firms* in which they may be partners."

Let us see how far the rule has been adhered to.

In Class 1, Mr. Nicholas Wood, F.G.S., is a *Juror*, and a medal is awarded to the Firm of Messrs. Wood and Dalglish, as exhibitors in the same Class.

In Class 3 Mr. C. Woollaton is a *Juror*; a medal is awarded to Abbot and Taylor, "for excellence of quality of hops, in the collection exhibited by "C. Woollaton and Sons."

In Class 4 Mr. Robert Fauntleroy is a *Juror*; the firm of "R. Fauntleroy and Co. are awarded two medals in the same Class.

In Class 27 Mr. William Spottiswoode, F.R.S. is a *Juror*; a medal is awarded in the same Class to Messrs. Eyre and Spottiswoode.

I hope that the Commissioners will cause a prompt enquiry to be instituted into these cases.

Why should "telegraphy" have been classed with philosophical instruments? How could a jury, by no means favourably known in practical telegraphy, especially in submarine telegraphy, judge of the merit of the various inventions and contrivances displayed. Professor Wheatstone and Thompson, and their eight fellow members of the Royal Society were not very likely to differ; "but," say they, "we called Mr. Fleeming Jenkin to our council, a gentleman of much practical experience and mathematical acquirements." Now let us see what were the qualifications of Mr. Fleeming Jenkin to award "medals" and "honourable mentions." Mr. Fleeming Jenkin states in his examination before the late Government Committee that his experience extended to about two years in the employ of Messrs. Newall and Co. Are there any of the submarine cables designed or operated upon by Mr. Fleeming Jenkin now in speaking existence? Mr. Fleeming Jenkin, in reply to Mr. Cyrus Field's enquiries as to the rapidity of communication through the new proposed Atlantic cable, states that by means of an improved "instrument designed by Professor Thompson (whose name, bye the bye, is mentioned no less than 31 times in Mr. F. Jenkin's evidence and reports) and himself, so many words could be transmitted. There are several transmitting instruments exhibited at Kensington, but only one receives a medal—Messrs. Siemens, Halske, and Co. If my readers will refer to pages 479—481 of the Government Report this award cannot much surprise them. Mr. Allan receives a medal for a *portion* only of his beautiful automatic system of telegraphy. Mr. Henley, Mr. Tyers, Mr. Wilde, and Mr. Reid's instruments are not even mentioned.—Yours, &c.,

NOT AN EXHIBITOR.

Miscellanea.

THE TELEGRAPH IN WARFARE.—A curious incident took place during one of the recent conflicts in Virginia. The Confederates had suddenly attacked a telegraph station belonging to the enemy, driving off the Union troops in possession, and with them the telegraph clerk. Unaware of what had taken place, the Federals continued to send orders and intelligence from head quarters; the information being coolly read off, and turned to profitable account by the new occupiers of the captured station. In due time, the Federals were made aware of the true character of the recipients of their communications, by a message in reply to their communications, and couched in very uncomplimentary terms.

ACCORDING to an an "approximative" calculation, a pedestrian travels two yards per second; an express train, 30 yards; a cannon ball, 200 yards; sound, a quarter of a mile; light, 192,000 miles; electricity, 288,000 miles, or eleven times round the earth.

THE PROCESS OF GALVANIZING IRON WIRE.—The wire is carefully annealed after it is drawn and welded into such lengths as may be desired, generally about one hundredweight, or the one-third of a mile; in welding it, it is selected, viz., all bad wire, split or broken, hard, or otherwise imperfect, is cut out; it is then put into diluted muriatic acid until clean, the wire is then placed upon reels, preparatory to being drawn through the bath of molten zinc; the bath is placed before the reels, and consists of a wrought iron tank, from 10 to 14 feet by 4 feet deep, and from 2 feet to 3 feet 6 inches wide, surrounded with a flue, which is supplied with coke; the wire passed over a roller, and through guides, to keep the wire separate, and into the molten metal in the bath; it is then passed through guides, having eyes, and is drawn out at the other end of the bath over V shaped rollers, and wound up on drums or reels, worked by a steam engine; the winding machine and drums are so constructed that in the event of any of the wires becoming entangled or broken, each drum can be thrown out of gear, stopped, and the wire repaired without interfering with the other drums there working. The end of each bundle, when nearly wound up, is welded to the next, and drawn through. The wedges on the winding-up drums are then taken out, and the bundle removed ready to be bound with wire, previous to being sent off.

"THE BRIDGE IS GONE!"—The following matter-of-fact romance is from the pen of Elihu Burrit, the learned blacksmith. We have seen it variously stated: in some instances, to the effect that human agency alone was instrumental in saving the train; and in others, that it was by the telegraph in the hands of human agents. Feeling naturally inclined to give the latter all the credit of the achievement, we proceed to notice its power of deliverance:—" During a storm and violent gale, the long railway bridge across the Connecticut, between Hartfield and Springfield, was lifted up by the wind, and thrown into the river beneath, two hundred yards in breadth, swelled at the time to a dreadful height by an unusual flood of rain. The line here was crossed by this bridge, elevated fifty feet above the stream, after an abrupt curve had been passed. On came a train, the engine blowing off its head of steam, breasting its way nobly against the gale, which almost threatened to check its progress, the hot iron hissing furiously in the falling rain. The passengers within congratulated themselves on their comfortable situation, thinking of the blessed homes and the firesides which they soon expected to reach. No one knew, or even suspected, that the bridge was gone. For two years, by day and night, the trains had passed and repassed, until safety had obliterated the thought of even the possibility of danger; but no bridge was there to receive them, and the long train, with its precious freight, rushed on towards the precipice of destruction. It was not customary to stop at this place, excepting to check the speed for the landing of passengers; but the people there had learned, through the instrumentality of the telegraph, the loss of the bridge, and kept a sharp look out for the approaching train. It came; the word is given, and they are safe. Every heart leapt from its place, and the head swam giddily with fear as the thought came of that fearful leap in the dark; and long will the passengers remember that dreadful road, and the friendly yet fearful cry of 'The bridge is gone.'"

To Correspondents.

X.—We are not ready to admit the conclusions inferred in the statement of your questions. The early academicians, in the days of the second Charles, were once puzzled with the question "Why does a vessel of water containing a fish weigh no heavier than the same vessel of water without the fish?" Ultimately the question was answered by disproving the statement contained in the query. When a charged cloud is overhead, if you will take a well insulated electrometer into the open air, the attraction of the electricity of the cloud for the substance of the electrometer will be rendered evident by the deflection of the needle, or the opening of the gold leaves. Under the attractive influence of the plus electricity of the cloud, the upper portion of the electrometer ceases to attract its own electricity, and becomes negative "by induction." The deflection is produced by the surplus electricity in the lower part of the instrument. The attractive influence exerted reciprocally between electricity and common matter is insufficient in this case to *overcome* the whole effect of gravitation or the power of flotation in the cloud. Except in the case of feathers and other light bodies attracted through very *short* distances, the effect of attraction has to be shown by attracting the body to be attracted to one extremity of a scale-beam. In regard to your first question, we may point out that a flash of lightning takes place as a series of discharges between several points, as shown by its zig-zag course. The cloud charged with electricity *does* exert an attraction upon all bodies on the surface of the earth; but it is only when this attraction is exerted through a short distance, as in the exceptional phenomena of waterspouts, &c., that the force of gravity can be completely overcome by the effects produced by the attraction.

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The Electrician.

Vol. II. No. 39.—August 1, 1862.

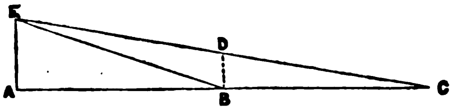
CONTENTS:

	PAGE
On the Comparative Periods of Charge of Various Lengths of Submarine Cable	145
Some Considerations on the Principles of Electrical Conduction and Accumulation	146
On the Fundamental Laws of Ohm and their Susceptibility of Improvement	148
The Universal Telegraph	151
Iron Covered Cables	152
The Student	153
Prices Current of Insulating Materials	153
Government Telegraph Contracts—(Leader)	153
Telegraphic News	154
Correspondence	154
Miscellanea	156
To Correspondents	156

ON THE COMPARATIVE PERIODS OF CHARGE OF VARIOUS LENGTHS OF SUBMARINE CABLE.

It may have occurred to the reader that, as the sections into which we suppose a length of cable to be subdivided do not, under the conditions which occur in practice, become charged separately and successively, but simultaneously become raised to the maximum of tension due to their respective positions, the results obtained in applying our system of analysis to ascertain the period of time occupied in charging various lengths of cable may be founded upon a purely gratuitous assumption. We have therefore to examine whether our method of considering separately the distribution of the total quantity of charge of each section, is equivalent to considering the consecutive distribution of each unit of electricity throughout the whole length of wire. By means of the following diagram we arrived at the conclusion, that if the charge of A B, connected to earth at B, is effected in 5 units of time, that of A C, connected to earth at C, will occupy $12\frac{1}{2}$ units of time. Dividing A C into two sections, and considering separately the distribution of 75 units of electricity upon A B, and 25 units upon B C, we found that the period of time necessary to charge the two sections is $7\frac{1}{2}+5$ units of time.

Fig. 1.



Let us now consider consecutively the distribution of each unit of electricity supplied to the wire A C. The first unit will not, as we have assumed, be stored up in A B, but will be divided between this and the length B C, in the proportion of $\frac{3}{4}$ of this quantity to the first length, and $\frac{1}{4}$ to the second section. (2.) Assuming as heretofore the resistance of the battery to be *nil*, the active force in charging the wire to be inversely as the resistance to the passage of the electricity of the charge in each section, and the time occupied in the charge as the quantity of electricity supplied, divided by the force under which the supply takes place, we have for A B,

$$A=10,\ Q=\tfrac{3}{4},$$

and $\frac{Q}{A}=\frac{3}{40}$=period of charge for this quantity;

and for B C

$$A=5,\ Q=\tfrac{1}{4},$$

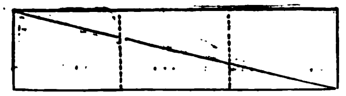
$$\frac{Q}{A}=\frac{1}{20}=\frac{2}{40}=\text{time of charge.}$$

The period of time therefore occupied in the distribution of one unit of electricity in A C$=\frac{5}{40}$. But this will be the same for every successive unit;* and $\frac{5}{40}\times100=12\frac{1}{2}$, the period occupied in effecting the total charge of 100 units of electricity.

We will now proceed to approximate, somewhat more closely than we have hitherto done, to the comparative periods of time in which two lengths of cable, of say 300 and 600 miles respectively, become charged from the same battery. Let A B (fig. 2), represent the first length, and A C (fig. 3), the second length of cable.

We will subdivide our *second* length into six sections, instead of into two only, as in the example previously given. To obtain a number representing the period of charge of the first length, we may divide this into three sections.

Fig. 2.



A 1 2 3 B

Contact being made at A with the pole of a battery, of which the other pole is connected to earth; the static charge of the wire, when the extremity B is insulated, may be represented by the rectangle upon A B. Under these conditions, the quantity of charge in the three sections respectively will be equal. Let this quantity =6 units, and the quantity in A B 18 units.

The period occupied in charging the first section being 1 unit of time, the first and second sections together will become charged in 3 units of time, and the three sections will become charged in 6 units of time. The numbers 1, 2, 3 represent the periods of charge of the sections respectively when charged consecutively by contact with the pole of the battery at A; these periods being as $\frac{Q}{A}$ in each case.

Let us now connect to earth the extremity B of the wire; the charge will be reduced to one-half, =9 units of electricity. The quantity of electricity accumulated in the first section will now =5 units, equal to $\frac{5}{6}$ of the former charge, and the period of charge for this section will be $\frac{1}{6}\times5=\frac{5}{6}$.

The quantity in the second section will be 3 units, $=\frac{3}{6}$ of the charge when the end B was insulated; and the time of charge will now $=\frac{2}{6}\times3=\frac{6}{6}$.

The quantity in the third section will be 1 unit $=\frac{1}{6}$ of the former quantity; and the time of charge will therefore $=\frac{3}{6}$.

The period of charge for the whole length A B$=\frac{5}{6}+\frac{6}{6}+\frac{3}{6}$ $=\frac{14}{6}=2\frac{2}{6}$.

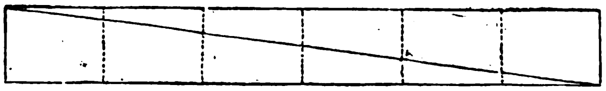
We will now apply the same method of analysis to the double length of wire A C.

The end C being insulated, it will take 36 units of electricity

* The static charge of a wire neither increases nor diminishes its absolute conductivity.

to charge the wire; 6 units being accumulated in each section. The periods occupied in charging each section consecutively, by contact with the battery at A, will be as the numbers 1, 2, 3, &c.

Fig. 3.



The extremity C being connected to earth, the total quantity of charge will be reduced to 18 units. The reduction in the quantity of charge for each section from A respectively will be $\frac{1}{12}$(or $\frac{1}{2}$ unit), $\frac{3}{12}, \frac{5}{12}, \frac{7}{12}, \frac{9}{12}, \frac{11}{12}$. Conversely, the amount of charge of each section from C will be as these numbers, the sum of which =18.

The period of charge of the first section from A will be ... ... $\frac{1}{12} \times 11 = \frac{11}{12}$

For the second section this period will be ... $\frac{2}{12} \times 9 = \frac{18}{12}$

For the third section " " ... $\frac{3}{12} \times 7 = \frac{21}{12}$

For the fourth section " " ... $\frac{4}{12} \times 5 = \frac{20}{12}$

For the fifth section " " ... $\frac{5}{12} \times 3 = \frac{15}{12}$

For the sixth section " " ... $\frac{6}{12} \times 1 = \frac{6}{12}$

The total period of charge for A C will therefore $= \frac{91}{12} = 7\frac{7}{12}$.

If therefore, according to this approximation, the retardation by induction in a line of 300 miles is expressed by the number $2\frac{2}{6}$, the retardation in a line of double the length will be $7\frac{7}{12}$; or, if $7\frac{7}{12}$ words can be obtained through the shorter length in a unit of time, $2\frac{2}{6}$ words can be obtained through the double length.

Our former ratio for the periods of charge of the single and double lengths was 5 : 12½, and the ratio we now obtain by a closer analysis is 28 : 91. But 5 : 12½ : : 28 : 70; we have therefore approximated somewhat more closely to the ratio of the squares of the lengths, which would be 28 : 104. In all cases, however, in which we may analyze the distribution of the charge in various lengths of wire, the ratio of the squares of the lengths will be found inapplicable by a sufficiently wide margin to justify us in rejecting the "law of retardation" founded on this ratio. The experimental results obtained by Sir Charles Bright and Mr. Edward B. Bright, and described in a paper read in 1854 before the British Association at Liverpool, appear to furnish tolerably correct data in regard to the comparative periods of charge of single and double lengths of wire. With 500 miles it was found that one-third of a second elapsed between the contact at one end and the maximum effect at the other extremity, and that with 1,000 miles of the same wire the retardation was one second.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 124].

Coulomb, therefore, with two equally and oppositely charged insulated spheres, found the attractive force to vary inversely as the square of the distance, and Sir W. Snow Harris, in the experiment I have described, obtained this result with *discs*, but only when the discs *were connected to the two armatures of a large Leyden arrangement.* These results of Sir W. S. Harris's experiments, I have shown, may be accounted for by that arrangement, even if it be granted *à priori* that equal quantities attract with the same force independent of distance. When, however, Sir W. S. Harris used discs, both insulated and unconnected with a Leyden arrangement, the attractive force only varied *inversely as the simple distance.* Thus he says,* "Take the discs A and B † of the electrometer, fig. 42," (a simple scale beam electrometer, similar to that represented in fig. 76), "both insulated, charge one, A, positively, the other, B, negatively, which may be easily effected in the way before explained; the forces taken at different distances, as in experiment 43, will be in the *inverse ratio of the distances.*"

Here, therefore, we have Coulomb's experiment repeated, only with discs instead of spheres, and the result is quite different; for whilst with the spheres the attractive force is as the *square* of the distance inversely, with the discs it is inversely as the *simple* distance.

When the upper disc is taken uninsulated, and the lower disc charged, but without a Leyden arrangement, the force varies still only inversely as the simple distance; thus Sir W. S. Harris says:—

"Take the suspended disc uninsulated and charge the fixed disc either positively or negatively; examine the forces at different distances, as in the preceding experiment, and the same law will be apparent."

It is evident, therefore, that the Leyden arrangement was the cause of the force varying inversely as the *square* of the distance, for without it, everything else being the same, the force only varied as the simple distance; and, indeed, Sir W. S. Harris observes:—

"In all these cases of electrical attraction it is quite immaterial to the conditions of the experiment whether one or both the bodies be permanently charged. In the case of both bodies being permanently charged, and with opposite electricity, then, as already observed, both bodies act similarly. *In order for the force, however, to vary in the inverse duplicate ratio of the distances, they must always be so circumstanced as to have a large inductive capacity.*"

Now, since with the Leyden arrangement attached, the attractive force varied in the inverse duplicate ratio of the distances, and since with no Leyden arrangement it was only inversely as the distance, it follows that with some smaller Leyden arrangement the force would vary inversely as some power of the distance between the first and second power.

If, for instance, to the disc m' a plate B (fig. 81) be attached, and placed close to some surrounding conducting surface, we should (if this plate were a certain size compared to the disc m') have all the conditions necessary to make the attractive force between the discs m and m' vary (within certain limits) inversely as the square of the distance between them; the disc m' and plate B being, of course, charged with a given quantity, and the disc m connected to surrounding objects. If now instead of the plate B a smaller plate B′ be substituted and placed further from the surface C C, the conditions would be altered; r in the formula $q' = \frac{r\,Q}{r + m\,r'}$ would be increased; and if now the attractive

* "Rudimentary Electricity," (Weale's Series) page 123, exp. 44.
† The discs m m'.

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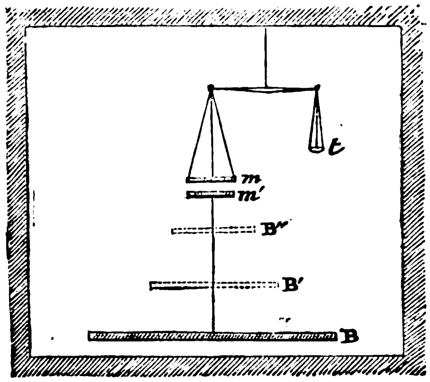
force between the discs be again tried, at the same distances experimented on as before, the attractive force would vary in-

Fig. 81.



versely as some smaller power than the square of the distance. If again, instead of the plate B′ a smaller one B″ be substituted, the conditions would again be altered; and if there be no plate B at all, then the lower side and edges of the disc m' would be surfaces exposed to the inductive action of surrounding surfaces, and would be also only a modification of the conditions produced when the plate B is used.

But these are the conditions under which Sir W. S. Harris found the attractive force to vary inversely as the distance.

It is evident, therefore, that the ratio of distance to attractive force varies according to the proportion existing between the inductive resistance (r') separating the surfaces between which the attractive force is measured, to that (r) between the other surfaces of the charged body and all the remaining surrounding surfaces; or to explain, in another form, on the proportion existing between the inductive capacity of that surface of the charged conductor, whose attractive force is measured, to the inductive capacity of the remaining surfaces of the conductor.

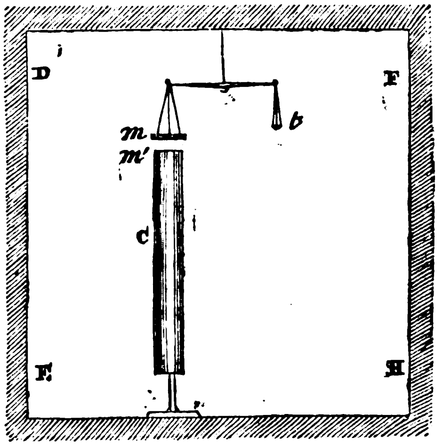
Now, since the proportionate distribution would be also affected by this relation of the inductive resistance between the attracting surfaces, to the inductive resistance between the other surfaces, it is evident the proportionate distribution must be *partially*, if not *wholly*, the cause of this alteration in the attractive force.

I have shown that as long as r, in these experiments of attractive force, is very small compared to r' the attracting quantity would vary almost accurately inversely as the distance, and that when a Leyden arrangement, of the size described in Sir W. S. Harris's experiment, is attached to the disc, that r *is* sufficiently small compared to r' to cause the alteration in the quantity on the discs to vary inversely as their distance separating them; but, it is not absolutely necessary in order that r may bear a small proportion to r' that the surfaces between which the resistance represented by r exists should take the form of a pair of flat plates or of the coatings of a Leyden jar. For instance, if a long insulated cylindrical conductor C (fig. 82) be charged, and the small uninsulated disc (m) of the scale beam electrometer be placed over one of its flat ends; then it is evident that r would be represented by the inductive resistance between the cylindrical surfaces of the cylinder C and the surrounding objects D E F H; and r' by the resistance between the end m' of the cylinder and the suspended disc m.

By increasing or decreasing the length of the cylinders, the ratio of r to r' could be altered to any extent, and, therefore, by increasing it sufficiently, r could be made so small that when the distance of the disc m, from the flat end m', is doubled, the quantity on the flat end m' (and which quantity constitutes the attracting force) shall be halved. Thus the same effect would be produced by the long cylinder as by a Leyden arrangement.

If the charged conductor be a large sphere, the same considerations would apply, and it is evident, therefore, that, in all this class of experiments, *the form and size of the charged conductor, and the position of the surrounding conductors*, influences the ratio

Fig. 82.



between the various distances at which the discs are set, and the quantity actually attracting in each case.

When the bodies are both insulated and charged with opposite electricity, the alteration in the distribution will also depend on the alteration in the inductive resistance in different directions.

Thus, in figure 79 it is evident that, as the spheres A and B are separated, the inductive resistance direct between them is increased, whilst that between each and the surrounding objects is decreased. The distribution will consequently alter as they are separated.

Now, if r' represent the resistance directly separating them, and r the sum of the resistances in the indirect inductive circuit, then if r bears a very small ratio to r, and r' be doubled, by increasing the distance between the spheres, the quantity on the surface of r', and which constitutes the quantity attracting them, would be nearly halved.

It is easy to see that the ratio of r to r' will vary the same as in the more simple case of a single charged conductor, with the form of the conductors and their relative position. Thus if two discs be placed parallel and close together (as in Harris's experiments) and widely separated from surrounding objects, then r' would be small compared to r. But if the two discs be placed edge to edge (so that they shall lay in the same plane) and their nearest points be separated the same distance as before, r' would be much greater as compared to r than in their previous position. When the discs in this position are separated more, the value of r' will rapidly increase, whilst r will be scarcely altered. It would be perfectly possible, therefore, that r should soon bear such a small proportion to r', that the quantity attracting should vary sensibly, inversely as the distances separating the two discs, in which case the attracting force would, if it be granted that attractive force of given quantities is not altered by distance, vary inversely as the square of the distance. And, indeed, this is not all, for so if the discs, being placed with their flat surfaces close to one another, be separated beyond a certain distance, r may, from being maller than r', increase to any amount greater than r', so that if separated sufficiently, the attractive force will begin to vary inversely as the square of the distance.

Further, it is perfectly possible, indeed, it seems highly probable, that two spheres should present almost similar conditions, and that, consequently, when separated more than a diameter or two, the direct resistance between them should be so great as compared to the resistance between each of them and the surrounding objects, that the quantity attracting directly between them should vary inversely as the distance separating them, and consequently that the attractive force should vary inversely as the square of the distance, as found by Coulomb.

These considerations of the effect on the attractive force

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produced by the redistribution of electricity, appear, therefore, to account for, and reconcile the very different results obtained by Coulomb with small spheres, and by Sir W. S. Harris with comparatively large discs placed very close together; for we see that with differently shaped bodies, different results should be obtained; and even that at different distances, the ratios of attractive force to distance will change. That is to say, although the attractive force may, with certain arrangements, vary within certain limits, sensibly as some particular power of the distance, if increased beyond these limits, the ratio will begin to vary, and ultimately the attractive force will vary as some other power of the distance. They further show distinctly the effect of the Leyden arrangement in Sir W. S. Harris's experiments, and why that arrangement should alter the relation between the attractive force and distance of the two discs experimented on from an inverse ratio to the simple distance, to an inverse ratio to the *square* of the distance.

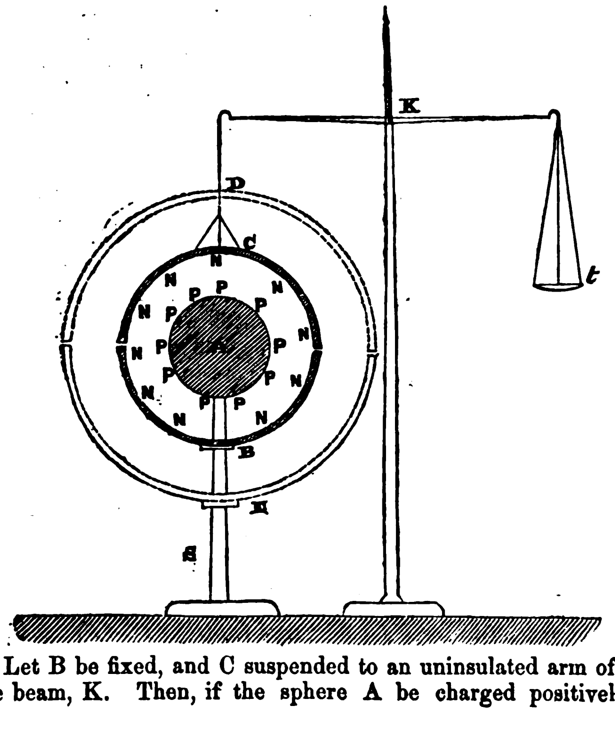
It is, I maintain, therefore, open to speculation, whether the alteration in attractive force is not entirely due to this alteration in the quantity attracting, by the redistribution that takes place in each case, and that if the quantity attracting is maintained constantly the same, the attractive force would not vary with increase of distance.

There seems strong reason to believe this, from Sir W. S. Harris's experiments with the Leyden arrangement; for I have shown that the quantity on the discs would be halved when the distance was doubled. Now, the attractive force was then reduced to a quarter. If in this state the quantity be doubled, thus bringing the quantity on the discs back to its former quantity, then, according to the law of quantity and attractive force, the attractive force would be increased as the square of the quantity, and would, therefore, again become *one*, or the same as before, although the distance separating the attracting quantities is doubled.

The following experiment, it appears to me, would determine whether the attractive force is altered by an alteration of distance between two surfaces on which there exists constantly the same quantity.

Let A represent a spherical conductor on an insulating support *s*, and surrounded by two uninsulated shells of metal, B and

Fig. 83.



C. Let B be fixed, and C suspended to an uninsulated arm of a scale beam, K. Then, if the sphere A be charged positively, an equal quantity of negative electricity will exist on the interior surfaces of the metallic shell, C B, surrounding it. An attractive force will, therefore, exist between every part of the sphere, and a corresponding portion of the shell, constituting an infinite number of forces between the shell and sphere in a direction towards the centre of the sphere. The resultant of all the forces between the suspended hemispherical shell and the sphere will constitute a force, tending to pull the former towards the latter, which may be measured by weights in the scale pan *t*. If now, for the semi-shells B and C, two larger semi-shells, D and E, be substituted, the upper one, D, being made equal in weight to C, then, the distribution on the sphere will be unaltered, and the same quantity will attract the shell D as that which previously acted on the smaller and nearer surface C. If the force which now attracts D be measured, the relation of distance to attractive force of a given and constant quantity of electricity could be determined.

(*To be continued.*)

ON THE FUNDAMENTAL LAWS OF OHM AND THEIR SUSCEPTIBILITY OF IMPROVEMENT.

BY RICHARD LAMING, M.R.C.S.

AUTHOR OF "STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY."

Throughout the whole range of the sciences and arts relating to mechanics, we are meeting with "resistance" at every step; the civil engineer finds it impeding the action of his machines, and whether the hindrance proceed from friction, gravity, inertia, or anything else matters not, he is enabled at once to disembarrass himself of all minute enquiry into the subject by falling back upon the use of one comprehensive term. With the same carelessness as to its nature, the natural philosopher often deals with resistance; he has to trace and measure physical forces, so that in his estimation resistance must be a force too, in order to be brought into antagonism; but whether it consist of one force, or more, he does not always stop to consider; under the generic term resistance he can dispose of any number of them in a lump. The mathematician too, following in the train of the physicist, need take no profounder view of resistance; to him it is quite convenient to regard anything as a homogeneous entity, and having expended upon it in that character his capacity for calculation, he presents us with demonstrations of what it can, and what it cannot do, and there he leaves it. And so, at last, resistance falls under the examination of some votary of Bacon who has a care to know of what it consists, in order that it may be handed back again in its real character for the mathematician to deal rightly with.

Will the electro-telegraphist, while claiming the subject as specially his own, be content to employ the dark mechanical conception of electrical resistance only for its practical usefulness? or, if he be philosopher enough to wish to enjoy intellectually the natural things he is making subservient to his purpose, will he, like the pure mathematician, restrict his enjoyment to the delights of numbers and quantities, and care not for the enlightenment of inductive reasoning? It will not be difficult to shew, even in so brief a memoir, that unless the electrician comprehend the agencies involved in the resistance he has to trace and compute, he may be both an engineer and a mathematician, and still doomed to find discrepancies between his results and observations, where he is looking only for accordances; and a thousand seeming indications of truth must, in the estimation of the natural philosopher, sink into comparative unimportance if contradicted by nature in a single instance.

Ohm, in using the resistance to electrical conduction which constitutes so fundamental an element of his system, does not pretend to know either its nature or its manner of acting; he is content to employ it purely as a mathematical device. In this absence of physical light his laws must lose something of certainty, and would do so even if their results were ten-fold more

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coincident with facts than our acquaintance with them has proved them to be; for it is quite possible that what he represents by the letter R may be made up of heterogeneous parts, liable, under change of circumstance, *to vary in ratios that are unequal;* and should that be the case, then, before it can be treated mathematically with absolute certainty of uniform precision, it would obviously have to undergo an analysis, in order that a separate and independent symbol might be used to represent each of its parts; for, unless each part were separately represented, the fluctuating value of R, as a whole, could never be traced through all its changes by any rules of proportion.

Mathematical considerations alone, then, might induce us to represent electrical resistance by two symbols instead of one, each denoting an element differing from its asssociate; if only by so doing we could extend the usefulness of calculation. And we have reason to think the introduction of a second symbol would be useful, for the two-fold character of Ohm's R is a conclusion proved in these pages on the best physical evidences, by which I mean such as bring conviction home to the mind of the critical enquirer, by combining minuteness of accuracy, with an extent of generality very far exceeding what has been presented by any other view of electrical causation, or that could with reason be expected in mere invention, however ingenious or elaborate. Altogether, therefore, there seems sufficient warrant for passing Ohm's fundamental laws in review, with the avowed object of ascertaining whether they be susceptible of improvement.

Beside the inherent evil I have referred to, there is another attendant on the use, or rather abuse, of Ohm's laws, for which the algebra is not responsible; to make it understood let us go back a few pages in electrical history. It was known at a very early period that all bodies do not conduct electricity equally well, a discovery that implied, of course, that time is occupied by the function of electrical conduction. Thenceforward we required only to be guided by a mechanical axiom namely, *equality of cause and effect,* to arrive at the conclusion that if a given linear conductor could transmit a given quantity of electricity in a certain time, then that conductor would require an addition to its sectional area, to conduct a larger quantity of electricity in the same time; this, in the progress of the science, became established also by observation, and the fact was expressed by saying—not simply that the larger conductor was the more capable of the two, but—that the smaller one resisted the passage of part of the electricity that the larger one could conduct; just as, in the parallel case of the transmission of water, we might assert that a pipe contracted in diameter, at any part, would resist the passage of a portion of fluid that it otherwise would have conducted. As a figure of speech, it was permissible, in either instance, to express the want of conductive capacity by supposing the active agency of a resisting force. The fact is not altered by the negative mode of expressing it; but it is very important to take care that we do not concieve it to be altered by mistaking the figure for a reality—the absence of one thing for the presence of another—functional incapacity for forcible antagonism.

So long as the figurative language of resistance to electrical conduction was used only in the narrative of facts, it remained unobjectionable; Faraday so used it, as also did Harris, and no one probably mistook their meaning; but so much cannot be said of the term now that Ohm has introduced it into his algebraic formulæ, where it is not only treated as a homogeneous physical agency, measurable in quantity, but so otherwise misconceived as to lead to a perversion of mathematical demonstrations into subversions of the common principles of mechanical philosophy. We could never have been otherwise told "there is no such thing as a wire that will conduct all the electricity capable of being furnished by a voltaic couple" merely because one algebraic quantity divided by any other always leaves some quotient. How many telegraphists are there who, like the writer of the assertion I have quoted, are suffering themselves to forget that the several quotients obtained by applying to different cases Ohm's formula, $I = \frac{E}{R+r}$ denote relative, and not absolute, quantities? Is there one among them who would require us to believe that a small quantity of water arriving by a pipe of limited diameter could not be all conveyed away by any conduit whatever, though it equalled in sectional area the disc of the moon?

Nor is this the full magnitude of the error which is being committed; other telegraphists, to whose mathematical demonstrations we could turn, would hardly think us credulous if we believed that the quantity of water flowing through a hollow straw, must of necessity increase *ad infinitum* with the means provided for carrying it away; for between that belief and what they assure us, there is not the smallest difference in probability. "Capacity for conduction (writes one) is never infinitely great, but must always be represented by a quantity which theoretically could be increased; therefore the amount of generation with any given source, in a given time, can never reach its maximum." It is really discouraging to physicists, who desire to propagate principles on which electrical action may be surely calculated, to find mathematicians thus confounding together the use and the abuse of demonstration which men can never question, and thereby converting it into an instrument of mischief. Ohm made electrical generation, mathematically, to be proportionate to the absence of resistance; certain of his disciples are teaching that it is so physically, that is to say, in its own nature, without any limit; whereas all that facts need for their solution is that the generation of electricity shall cease whenever its conduction away demands a conductor of larger dimensions, or else a greater intensity of action than the voltaic apparatus can supply; and at that point it will cease according to the principles which have lately been so fully laid down.

Great indeed are the advantages to be derived from the legitimate use of mathematical calculation; but it is questionable whether under any circumstances they are not far exceeded by the importance to the telegraphist of holding clear views of electrical causation. Can we then reprobate too severely that misapplication of calculation which has introduced such confusion as to make a cause to be dependent upon its own effect, and so to reverse the natural order of things as to set, figuratively speaking, electrical generation upon the watch for opportunities of electrical conduction? To this obloquy the fundamental formula of Ohm, above cited, whether he intended it or not, is certainly liable. That matter conducts electricity we know; that a certain quantity of matter can conduct only a limited quantity of electricity in a given time is also a fact; but to conclude that a quantity of conducting matter infinitely great, cannot conduct a quantity of electricity furnishable by a voltaic combination infinitely small, is to assign to the apparatus a rate of productiveness not proved by observation, inconceivable on physical considerations, and which, if a fact, would be without any parallel in the whole range of the physical sciences.

With these convictions resting in my mind, I shall make no further apology for collating from the newly published view of electrical action fresh data, in the hope of deriving from them symbols that shall more perfectly represent the natural agencies involved in electro-telegraphy, and by so doing improve upon its fundamental laws themselves.

Let G be the galvanometer indication, varying with the quantity of electricity in motion round the needle.
- E an electromotive couple and cell.
- n the number of couples and cells in series.
- S the specific conductivity of matter, in each case varying as the square roots of the intensities of the electricity under conduction.

then will be also—

I the inertia in n E = greatest length of liquid conductor between any couple.

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i the inertia in the polar conjunction = quantity of electricity passing through any section of the conjunctive conductor $\times$ the length of its passage.

C the conductivity of n E = the lowest product of the multiplication of S at any transverse section of n E by the area at that section.

c the conductivity of the polar conjunction = the lowest product of the multiplication of S, at any transverse section of the conjunctive conductor, by the area at that section.

Q the quantity of electricity furnishable to polar conjunction by n E, with a given distance between the plates. . . . } = smallest sectional area of n E in operation.

I′ the intensity at the poles of n E when they are not conjoined . . . . } $= n\ E^2$

i' the intensity of action in the polar conjunction, when the poles of n E are in communication, and c is greater than C . . . } $= E^2$

Electricians who have made themselves familiar with the principles of electrical action pourtrayed in the "Steps to Theory," will need but little explanation of these data, as they have been all circumstantially led up to; I shall assume that what was therein said is for the most remembered, and take the liberty of again referring to it any reader who may find the few following remarks insufficient to make the whole subject intelligible—or if he will address me through The Electrician, I will further elucidate any point upon which he may experience a difficulty.

I, or inertia in the cell of any couple, is in effective amount simply in proportion to the length of a line joining the two electromotive plates; because a given amount of inertia is experienced each time that a particle of electricity, entering at the end of the line from the positive element, stops, and subsequently moves from, a particle of common matter, and because, also, the number of common particles is as the length of the line. The inertia does not increase with the size of the plates, for every line of electricity in motion is individually and equally urged onward by electromotive force, the inertia in all the lines, however numerous, being overcome simultaneously; and for the same reason, inertia is not increased by adding to the number of cells, as the electromotive force then still bears to it the same proportion.

i, or inertia in the conducting communication uniting the poles of a voltaic battery, will, in every case, vary as the quantity of electricity in a perpendicular section of the current multiplied by its length; this is consequent upon the same reasoning. The quantity of electricity in every part of the conjunctive conductor, however much it may vary in nature and in sectional area, will always be equal, though, of course, the density of the current will not be uniform unless the conductor be so. And the quantity of electricity in any given section of the conductor will be greater as the plates are larger, up to the limit of the conductivity of its most strangulated part *under the existing intensity;* and beyond that limit it will still become greater, if the increased size of the plates be accompanied by an increase in their number for augmenting the conductivity, the latter always varying as the square roots of the intensities.

C, the conductivity of a cell of electromotive elements, is like the conductivity of all linear things, as its sectional area multiplied by its specific conductivity at the time being, selecting for the calculation, as in the case of every other conductor of variable dimensions or nature, the data that afford the minimum product. The same is true also of any number of such cells, which, if all be alike, have the same conductivity as a single cell. If any cell in a series have a fluid conductor of lower specific conductivity than the rest, it will impose its own limit of efficiency upon all the others, unless it make up for its lack of specific conductivity by an increase in operating area.

c, the conductivity of a polar conjunction. To this, also, the remarks just above made exactly apply. As different substances have naturally, at any given intensity, different amounts of specific conductivity, and as the specific conductivity of any particular substance varies with its sectional area, we shall arrest the passage of a current, more or less, if at any part of its length, we sufficiently either reduce the thickness of a wire, or substitute for it a material of lower specific conductivity. But if the change made in either of these ways be not great, the current may not be checked; for example, a short and thin wire interposed between the divided ends of a polar conjunction, may change c, from being greater, to less than C; upon which a rise in intensity would ensue, and under its influence the conductivity of the thin wire might become as great as that of the unsevered wire in the first instance, and the current pass as freely as before.

Q, the quantity of electricity that can be furnished in a given time by a cell of voltaic elements of given effective dimensions, being taken as unity, then, two such cells in the same time can furnish two such unities of quantity; and we cannot see any cause why either a larger or a smaller quantity than two unities should be furnished by the two cells, on the supposition of their forming only one cell double in its effective dimensions. Bring this reasoning to bear upon the case of any greater number than one cell worked in series; we may imagine the series to have its poles united by a wire of equal conductivity to the battery; in which case we shall have a total quantity of electricity liberated in a given time, varying as the number of cells; but, inasmuch as each cell hands over its electricity in the given time no further than to the cell next in succession, it will occupy for its arrival at the conjunctive conductor as many units of time as there are cells to be passed through; whence it follows, that the quantity entering the polar conjunction in an unit of time will be the same for one or any number of like electromotive cells.

I′, the intensity of the disjoined poles of an electromotive apparatus, is practically known to increase as the voltaic combinations are more numerous; and, in the absence of all information as to the electrical causation by means of which one of the elements acquires electricity from another element (into which the published "Steps to Theory" have not yet been extended), it is quite consistent with the principles of mechanical philosophy to expect that what one cell of given element can do, any other similar cell of elements can also do; and from that it seems to follow, as first said, that the total quantity of electricity disturbed from the natural conditions of rest by an electromotive apparatus, will be in simple proportion to the number of its active combinations, as in fact we observe to be the case when we measure quantities by the electrometer. Now the equation under consideration is founded simply upon that fact, in conjunction with the electrical law of quantity.

i', the intensity of electricity in a polar conjunction, whose conductivity is greater than that of the electromotive cells, must be necessarily so much less than I′, as to allow the conductivity of the conjunctive conductor to fall to equality with that of the cells. This reduction of c to the lower value of C is easily arrived at by the theory. The quantity of electricity circulating in any transverse section of an electromotive cell, or in its conjunctive wire is the same; and it is not altered by placing any greater number of cells in series; but when the poles are not conjoined the quantity of charge accumulated there is as the number of cells; therefore the reduction in quantity by joining the poles by a wire in which c is greater than C, is as the number of cells less one, and the consequent reduction of intensity as the square of the number of cells less the square of one cell.

We may, in practice, observe this reduction very palpably in the phenomena presented by the electric column of De Luc. In that instrument the conduction from one of its extremities to the other, may, by interposing dry paper between each pair of the dissimilar metals, be rendered so imperfect that the full intensity due to the arrangement is not obtained until after the lapse of a very sensible period of time, although one of its poles be all the

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while in free communication with the earth; but on placing a wire between its poles the intensity undergoes its reduction instantaneously. It may also be easily observed by operating with certain elements and cells, if the series be sufficiently extensive.

While these data present to us a view of electrical action, founded upon mechanical principles, more specific than the data of Ohm, they supply us with formulæ that will embrace a far greater number of practical results. There will, too, be a general analogy between the old and new demonstrations, as, indeed, must necessarily be inevitable so far as the calculations of Ohm have been founded upon actual observation, and the others upon the causation of the facts observed; but they are marked by differences, and therein the new formulæ have the advantage. It may suffice to give one example:—in Ohm's equation,

$$I = \frac{n\,E}{n\,R + r}$$

In which I is the quantity of electricity or galvanometer indication.
E the force of each electromotive combination.
n the number of electromotive combinations.
R the resistance of each electromotive combination.
r the resistance of the conjunctive conductor.

The value of I increases with *every* diminution in the value of R or r; and in the formula proposed in place of it.

$$G = \left.\begin{matrix}\text{the lower quotient of} \\ \text{the two equations}\end{matrix}\right\} \frac{C}{I + i} \text{ and } \frac{c}{I + i}$$

In which G is the quantity of electricity or galvanometer indication.
C the conductivity of any number of electromotive combinations.
c the conductivity of the conjunctive conductor.
I the inertia to be overcome in any number of electromotive combinations.
i the inertia in the conjunctive conductor.

The value of G also increases with every diminution in the value of I or i, but in the case of a wire of given length the value of i itself, unlike that of r, may remain constant while the sectional area of the wire is subjected to variation within wide limits; because, if its conductivity be great enough to pass all the electricity under the intensity that would be exerted by a single electromotive couple and cell, no effect can be produced on making the conductivity greater by enlarging the wire, as i is independent of sectional area.

It is a singular commentary on the above formula of Ohm, though it by no means detracts from its merit as an ingenious contrivance, that according to the theory of definite electrical attraction the only part of the symbol R, or r, that represents physical truth has conduced least to its mathematical usefulness; while it has derived its coincidence with observation chiefly from what really has had no physical existence, inertia having comparatively but little influence, and the absence of conductivity being a mere negation.

THE UNIVERSAL TELEGRAPH.

Invented, 1839, Improved, 1858.

BY CHARLES WHEATSTONE, ESQ., F.R.S.

The limited extension of the ordinary telegraph, as a means for private communication, arises from the fact that the whole of the instruments at present working in this country, either as signal or printing apparatus, require great skill and practical proficiency on the part of the operator, both in manipulation, and also in the translation of the arbitrary signs they exhibit into ordinary language. Persons specially trained and educated are, therefore, required to work them, entailing a very expensive system of offices and clerks; while the employment of voltaic batteries in the generation of the current is also a fruitful source of expense, trouble, and difficulty in the working of the instruments from the gradual decay of strength to which they are subjected requiring constant attention and renewal, besides the inconvenience of form consequent upon the use of such an arrangement.

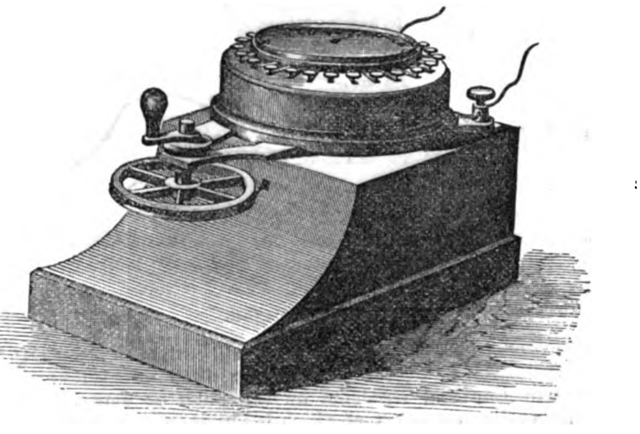
These objections Professor Wheatstone has entirely overcome in his new patent of 1858, the communication being maintained in the ordinary alphabetical language.

The Universal or Alphabetical Telegraph affords a simple and easy means of rapid and instantaneous communication between distant stations, without the employment of any galvanic apparatus or corrosive acids.

The instruments are at all times in readiness for immediate use, without previous preparation, and the communication is maintained in the ordinary alphabetical language, by the most simple means, so that any person, without previous instruction, is able to work them. The speed of transmission attained after a little practice, is at the rate of *one hundred* letters per minute, while they indicate the various signals with a steady dead-beat movement, and give perfect security to the accuracy of the message by the certainty of the transmission. The instruments require only a single wire as thin as pack-thread to work them.

The "Universal Telegraph" consists of two distinct parts or apparatus, the "*communicator*" for sending the message, and the *indicator*" for receiving the message.

The communicator consists of a small box, upon the upper surface of which is a fixed dial, having its circumference divided into thirty equal spaces, marked with the twenty-six letters of the alphabet, the three points of punctuations, and a +, with an inner circle marked with the nine digits and a +, the figures being repeated twice. A hand or pointer in the centre of the dial is made to rotate by mechanism, and points at the will of the operator, to the letters or figures required to be indicated. Round the circumference of this lettered disc are thirty small keys or buttons, which can be depressed by the finger, one for each letter or sign.



THE COMMUNICATOR.

In its interior construction, the box contains a permanent horseshoe magnet with coils for producing the necessary magnetic currents. An exterior handle, on revolution by the hand, or other means, causes an axis carrying a soft iron armature in the instrument to revolve. This armature is so arranged upon the axis as to be in close proximity with the soft iron cores of the coils on the poles of the horse-shoe magnet, so that at every revolution of the axis with which the handle is connected, the soft iron amature passes over the poles of the magnet; and at the moment of making and breaking contact, induces currents of electricity, moving in opposite directions through the wire of the coils, if the circuit be complete. These induced currents through the coils taking place each time contact is made and broken during the revolution of the soft iron armature with the poles of the magnet; a succession of currents or waves of electricity is obtained by the continuous revolution of the handle attached to the axis carrying the armature.

The mechanism of the communicator is so arranged that when any one of the thirty keys round the dial is pressed down by the finger, that key has the effect of cutting off the passage of the current along the line and through the instrument, and of making a short circuit with the earth so long as it remains depressed. When any other key is similarly depressed, a simple piece of mechanism causes the depression of this key to elevate the former key, open the electrical circuit, and allow the induced currents derived from the magnet to flow in succession through the instrument and along the wire to the distant station, until they are again interrupted and passed into the earth by

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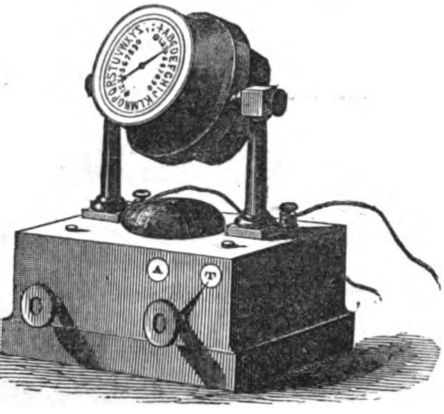
the depressed key. This short circuit contact is made by means of a loose carrier arm attached to the axis which carries the pointer on the dial, and thrown in or out of gear by the depression or elevation of a key. Motion is communicated to this axis by a bevilled wheel working into a pinion fixed to the axis carrying the armatures, the motion being so adjusted that for every separate current induced in the coils, the hand shall move one space or letter on the dial. The keys, therefore, being depressed in succession will each liberate one current, or thirty distinct currents during an entire revolution of the hand round the dial, fifteen in one direction and fifteen in the opposite direction.

For every current transmitted (these currents being in succession in different directions) the hand of the communicator, and those of the indicators at the near and distant station, will simultaneously advance step by step until the letter opposite the depressed key is reached by the pointer. The instant this letter is reached, a short circuit is made by the carrier; the current no longer flows through the telegraph wire and indicators, but passes into the earth until another key is depressed and the circuit is again opened, and so on in succession until any number of required signals or letters has been registered.

The indicator, externally in appearance something like a watch, is placed on a small stand in any convenient position for observing the dial. The face of the indicator is spaced into thirty divisions like the communicator, with its double circle of letters and figures, and its movable hand or index. A step by step motion is imparted to this hand by means of an electro-magnetic apparatus, which consists of two permanent magnetic bars or needles fixed to an axis, and lying parallel between two small electro-magnetic coils with soft iron cores. These



THE INDICATOR.

electro-magnets are so arranged that when a current of electricity from the communicator passes through the coils, their armatures exercise a mutual attraction and repulsion on the poles or extremities of the magnetic needles, the effect of which is to impart a backward and forward motion to the axis carrying the magnetic bars. Fixed to the end of this axis is a short vertical arm, carrying a small escapement wheel of fifteen teeth, the axis of which carries the pointer on the dial, and to which a step by step motion is imparted by the rotation of the escapement wheel working to and fro against fixed stops or pins.

The stand of the indicator is furnished with a lever turn-plate, by which the alarum, A, for calling attention, or telegraph, T, can be thrown into circuit according as the lever is turned to A or T.

Whenever the telegraph is not in use, the alarums at each end should be placed in circuit, so that on turning the handle of the communicator and depressing the key, the first currents transmitted through the circuit will cause the bells at both ends of the line instantly to sound, and call the attention of the clerk or operator at the distant station.

IRON COVERED CABLES.

The more the causes which have led to so many disastrous failures in submarine telegraphy are sifted and enquired into, the stronger becomes the conviction that the favourite plan of strengthening and protecting our cables with iron exposed to the corrosive action of sea water, is utterly inadequate for the purpose in view. In fact, experience proves that to envelop our cores in naked iron, is to lessen rather than increase their safety. It is remarkable that, until lately, comparatively speaking, this prolific source of danger to cables has received but little or no consideration—that while a vast amount of ingenuity has been expended upon the construction of instruments, in investigating the laws which govern the transmission of the electric current, and in discovering the best insulating materials, &c., very little attention has been paid to the external requirements of our cables.

In almost all the cables hitherto submerged, the insulating cores heve been sheathed in iron wires, and in numerous attempts which have been made from time to time to repair or recover cables which had failed, it was found that the iron wires had been completely eaten away by corrosion, and the insulating core exposed to injury by attrition, &c. Mr. Latimer Clark in his report to the directors of the Red Sea Telegraph Company (published in this Journal of the 25th ult.), states .—" The electrical condition of the copper and gutta percha core was generally so good, that, when properly covered, it is fit for re-submersion; *but owing to the entire absence of all protection, the iron was corroded away, that the cable, when suspended over rocks or submarine valleys, gave way spontaneously, breaking up in short lengths.*" The evidence of other experienced telegraph engineers may be adduced, confirmatory of the inapplicability of unprotected iron sheathing.

We have carefully read over the voluminous evidence given before the Government Committee, consisting of some 5,000 questions and answers, occupying no less than 280 folio pages. No less than 44 witnesses were examined, yet the danger from corrosion had evidently been foreseen but by few. We will place before our readers the statements as they appear in evidence.

Mr. J. W. Brett, in answer to Mr. Saward, states, with respect to the Dover and Calais cable, which had recently been taken up to be repaired:—" In some parts the iron is very much corroded, where it has become in contact with the lime and the chalk rocks." Mr. Canning, who had examined the same cable, adds:—" In many places the outside wires appear to be very bad indeed, and eaten away, but to a very small extent in others; it is very much rusted, and, in fact, so much so that there is a very small portion of wire holding or remaining." Mr. W. H. Preece mentions also several instances of corrosive action having impaired the iron sheathing of the Channel Island telegraph cable, and adds:—" Perhaps you would allow me to observe, in speaking of corrosion of cables, that I am decidedly of opinion that no cable should ever be submerged upon a rocky bottom, or upon a bottom likely to be swept by tides, without having some exterior shield to protect the iron from this corrosive action." Mr. R. S. Newall says:—" From our experience in laying the Red Sea cables, and finding that the iron wire is now completely corroded off it in various places, I think that it is worse than useless putting it on (the iron sheathing) in any water except shallow water and near the shore, to guard against ships' anchors." * * * " We found the same thing occur in this Holyhead cable, that the iron wires were completely corroded off it." Mr. F. C. Webb, who has had considerable experience in the laying and repairing of submarine cables, in his paper read before the Institution of Engineers, February 23rd, 1858, gives the following as the result of his experience:—" When the cable was thus buried, it was found to be in perfect preservation, the galvanized surface being as clean and good as when the cable was first laid; whilst in those places where it lay on the surface, it was eaten through, extending, in many parts, for one or two feet in length, to such an extent, that it was only held together by a portion of one outside wire. The gutta-percha and hemp were undisturbed, retaining the impression of the outer wires, thus showing that the decay was not caused by mechanical injury, but by oxydization, probably the result of a galvanic action. The galvanized surface had also entirely disappeared, where the cable was not buried. This decay, where the cable lay on the surface, fully accounted for the invariable fracture of the cable seawards of the ship when it was grappled for, and lifted outside the bank." And, again, in his evidence before the Government Committee:—" In some places, however, the outer wires are much eaten by rust, and at such places a very slight strain would break them. I have seen places on the rough grounds where the outer covering was completely eaten through for a few inches, whilst a few yards off from the same spot the cable was quite sound and strong." Mr. W. Mayes, speaking of the Red Sea cable, states:—" The cable appeared tight when hauled up, and in good condition generally; but at irregular intervals, sometimes of a few yards, sometimes of miles, there were places in the cable with many, and occasionally all, the iron wires broken and corroded, as though they had been broken some time." * * * " As the wire became weak from corrosion, it broke, being no longer able to bear the tension originally put upon it." * * * " I think that the total strength of the cable was diminished by about an eighth—not more than that—from corrosion or rust." * * * " It has been stated that it (the iron sheathing) corrodes most on muddy bottom. I think that it corrodes nearly equally on every kind of bottom."

Mr. C. F. Varley, in his report of his efforts to recover the Atlantic cable in the neighbourhood of Newfoundland, states:—" The recovered

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cable varied in condition very much, and what is most important is, that even those portions which came out of the black mud were so perished in numerous patches, that the outer covering parted on board during the process of hauling in."

The highly interesting paper read by Mr. W. H. Preece at the Institution of Civil Engineers, in November, 1860, and the important discussion which it gave rise to, afford much valuable information upon the subject of deep sea telegraphy, had more especially as the important question as to the ultimate effect of corrosion upon our numerous submerged iron-covered cables become a source of the most serious misgiving and well-grounded apprehensions. In all attempts made to repair or recover cables, whether in the Atlantic, the Mediterranean, the Red Sea, the Black Sea, or on the English coast, the work of corrosion manifests itself to such an extent, that the magnitude of the danger can no longer be ignored or concealed. Telegraphic enterprise for a time has become from this cause paralyzed, and its future involved in doubt and uncertainty.

(To be continued.)

The Student.

Erratum.—P. 102, col. 2, line 6; for "a current of electricity traverses the wire in the *same direction* as that which would be required to produce a magnet with its poles similarly disposed in regard to the helix," substitute "in a *contrary direction* to that &c."

We hasten to correct the above inadvertence, which we discovered on a reperusal of our former article. We are anxious that no mistake, accidental or otherwise, of any importance, should be allowed to pass; and we shall feel grateful to those of our readers who will point out any such errors they may observe. We can scarcely imagine that the above should have escaped the observation of many of the subscribers to the ELECTRICIAN; and we regret that our attention has not, ere this, been called to it.

A few notes upon the direction of induced currents of electricity, may be of benefit in enabling the student to comprehend clearly the effects which take place in the magneto-electric machine, and the induction coil.

The phenomenon termed by telegraphists *false discharge*, which is best observed in overland wires worked on the Morse system, or in the circuit of which a number of electro-magnets are placed, is due principally to magneto-electric induction. While the circuit remains complete, the soft-iron cores within the coils of wire, are possessed of magnetic polarity; when the circuit is broken, the magnets are virtually removed from the coils, and a current of electricity in the *same direction* as the battery current, takes place through the wire. This current may be noted by "cutting out" the battery and replacing it by a galvanometer one terminal of which is connected to earth. Conversely, when the circuit is completed and the cores become magnetized, a current in the reverse direction to the battery tends to traverse the circuit. This current is, however, overpowered by that from the battery; but the magneto-electric effect may be measured by the *expenditure of battery power* necessary to produce the magnetic effect. The retardation of the electric signal—very slight under ordinary circumstances, which is occasioned in this case by the reverse current, is the equivalent of the retardation occasioned by the false discharge.

A coil of wire, without any enclosed core of soft iron, possesses magnetic polarity in the same direction as that which would be given by induction to the soft iron. The same phenomena therefore occur, in a less degree, when the current from a battery, traversing a helix or coil of wire, is interrupted and renewed. It may here be observed that a *straight* wire through which a current is passing, exhibits magnetic polarity, as may be shown when the current is of great quantity, by plunging the wire into iron filings. The polarity appears, however, in this case, in a direction at right angles to the axis of the wire. There is probably a connection between this fact and the production of a current, in the same direction as the battery current, when the latter is interrupted in a wire of considerable length. The secondary current is, in this case, evidenced by the bright spark which occurs when contact is broken in a cup of mercury. This "induction of a current upon itself" belongs to a class of phenomena, which are as yet very imperfectly understood.

The attentive reader of our former articles on magneto-electricity will remember that the two currents produced by withdrawing a magnet from a coil, and again introducing it with its poles in the reverse direction, are in the *same direction*. This operation is virtually performed, twice during every revolution, in rotating a permanent magnet so that its poles may pass in proximity to the extremities of an armature inserted within a coil, as in the ordinary magneto-electric machine. But if, without allowing the soft-iron armature gradually to lose its polarity, we adopt means for instantaneously *reversing* this polarity, we may obtain the two currents simultaneously. Supposing, therefore, that we could rotate our permanent magnet with sufficient rapidity, we should obtain but two currents, in reverse directions, and of twice the tension and quantity of each of the consecutive currents above mentioned. Mr. Thomas Allan has, we believe, realized these conditions by arranging several horse shoe cores of soft iron, with their coils, upon the same axis, and causing the same to revolve in front of a compound magnet, composed also of several horse-shoes upon the same axis.

In the induction coil, the direction of the current is in accordance with what might be presumed from the above data. When the circuit of the battery is completed through the primary wire, an induced current traverses the secondary circuit, in the reverse direction to that producing the magnetic effect. When the primary circuit is broken, the direction of the circuit in the secondary wire is the same as that which would be required to produce magnetic polarity of the same kind as that which the core is then *losing*, *i.e.*, the same as the current from the battery. It is to be borne in mind, therefore, that the production of an electro-magnetic effect, in other words, the production of magnetism by means of an electric current, is the *converse* of the operation of producing a magneto-electric effect, or an electric current by means of magnetism. By the action of the commutator, the magneto-electric effect may be increased by reversing the polarity of the magnetized core.

When the bundle of iron wires forming the core of the induction coil is withdrawn, the currents produced by completing and interrupting the circuit of the battery through the primary wire are in the same direction as in the former instance. Although the currents may in this case be ascribed principally to what is termed dynamic induction, the primary coil becomes virtually a magnet, and, according to its polarity, produces an inductive effect in the secondary wire.

PRICES CURRENT OF INSULATING MATERIALS.

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Fine	2s. 6d.	per lb.
Genuine mixed	1s. 11d. to 2s.	„
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Para, fine	1s. 9d.	per lb.
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July 31, 1862.

WM. KIRKMANN,
4, Howford Buildings, Fenchurch Street, E.C.

GOVERNMENT TELEGRAPH CONTRACTS.

WE are glad to see, in the *Times* of Tuesday last, notice of a motion by Sir MORTON PETO for the production of the correspondence, &c., relating to the Malta, Tripoli and Alexandria Telegraph.

It is now a considerable time since the accumulated correspondence on telegraphs has been printed in the form of one of those books entitled "Further Correspondence," &c., and during that time the large contracts for the making, laying, and working of the Malta, Tripoli and Alexandria telegraph, have all fallen, one after the other, into the hands of one firm. The details and correspondence on all these matters form subjects of interest to many telegraph engineers and contractors, and it is astonishing that so long a time has been allowed to elapse without any honourable member moving for the production of these papers. The public have not been informed on what terms the contract for the working of the line, involving a large revenue, has been granted to Messrs. Glass, Elliot and Co., nor the reasons which induced the Government to hand over the working of the line to the firm in question, in preference to a telegraph company.

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It is exceedingly important, also, to the progress of telegraphy, that the receipts and profit on such a line of telegraph should be made public. When a new line is proposed, the first thing asked by those who are canvassed for subscriptions is, " What profit do the existing lines give?" Now, if the Malta, Tripoli, and Alexandria Telegraph had been worked by a joint stock company, this information would have appeared regularly on their half-yearly balance sheets; as it is, however, we cannot expect a private firm to make public their profits, and we must be content with information as to the amount of traffic on the line, from which a rough approximation may, perhaps, be formed.

It is to be regretted that most of the steps taken by the Board of Trade in these matters have been carried on with great privacy, tending generally to a monopoly, a course which is exceedingly detrimental to the progress of telegraphy.

When the Board of Trade and Atlantic Committee proposed an enquiry into telegraphic matters, principally, it was supposed, for the future guidance of such undertakings, most of the practical and scientific men acquainted with the subject came forward, and tendered their information and evidence, and, indeed, many gave up their time gratuitously to experiments, &c., of considerable importance. In return, it might have been expected that the Government, when they actually began to act in these matters, would have been guided to some extent by this evidence, and the Report of the Committee, have acted somewhat openly, and have published their proceedings for the benefit of future telegraph companies. Instead of which, we find, directly there are actually any contracts to be let, appointments to be made, or money to be spent, the same quiet, secret, and hasty dealing with a single firm, as of old; the cable and working all left to this firm, without anyone knowing the why or wherefore, or on what terms; a cable laid of no great strength, and no attempt in any place to construct, if possible, land lines, or to protect the iron wires. We find, in fact, that the Government Telegraph Committee, and those who were kind enough to give evidence, were merely composing a " text-book " for the guidance, in the details, of anybody the Government might appoint as engineer; but that, so far as any general rules of the policy to be adopted in such matters is concerned, the Report in question is a dead letter. The moment there is really " *business to be done*," the Board of Trade adopts very much the same policy as that which had been previously adopted by the old companies, and which has generally had such a disastrous effect on submarine telegraphy.

Telegraphic News.

UNITED KINGDOM ELECTRIC TELEGRAPH COMPANY.

The annual meeting of this company was held yesterday at Gresham House, Admiral Sir H. Leeke in the Chair.

The report stated that the company had gained their Act, and were now in a position to erect and maintain telegraphs all over the kingdom, without incurring rentals to canal and other companies, and with such advantages as would secure success.

The Chairman, in moving the adoption of the report, adverted to the excessive opposition which they had encountered, both in and out of Parliament. The company was in a most satisfactory condition, not in a financial point of view, although they had a handsome balance at the bankers'. He had not the slightest doubt they would become the first telegraph company in the kingdom. By this time next year the company's line would be extended, and its financial position would be improved at the same time.

Mr. Croll seconded the motion for the adoption of the report, which was carried.

Mr. Andrews (the secretary) remarked that a low rate for messages had been introduced on the Continent with great success.

On the motion of Mr. Robinson, a vote of thanks was passed to the directors for their general exertions to establish the company.

The retiring directors and auditors were re-elected, and the proceedings terminated with thanks to the secretary.

PROGRESS OF SUBMARINE TELEGRAPHS.

A telegram lately received announces the successful submersion of the first portion of a new telegraph cable between England and Holland. Owing to the increase in their message traffic between this country and the continent, the Electric and International Telegraph Company entered into a contract with Messrs. Glass, Elliott, and Co., of Greenwich, for a new line to be laid between Lowestoft and Zandvoort. The steamer *Hawthorns* shipped 48 miles of the cable last week, and the whole was successfully payed out under the superintendence of the engineers, Messrs. Canning and Clifford, and the Electricians, Messrs. De Sauty and Saunders; the Electrician of the telegraph company, Mr. C. F. Varley, being also on board. The cable is the heaviest yet constructed, and contains four conducting wires. The English shore end (15 miles) weighs no less than 16 tons per mile, and is above two inches in diameter. The remaining portion will be shipped immediately.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

DEEP SEA CABLES AT THE INTERNATIONAL EXHIBITION.

To the Editor of The Electrician.

Sir,—The wretchedly insignificant position assigned to telegraphy, is, and will be, the standing reproach of the International Exhibition. While other departments of art and manufacture, of infinitely less importance, were apportioned almost any reasonable amount of space their respective exhibitors chose to ask for, Telegraph Cable and Electrical Instrument manufacturers were allowed a mere fraction of the room they individually required, because the boundlessness of the shortsighted munificence of Her Majesty's Commissioners, assigned to telegraphy a mere corner of the nutshell which contains philosophical instruments and processes depending upon their use. This paucity of space, however, preposterously and absurdly inadequate as it is, might have been endurable had the same justice been done to this most mighty of modern sciences, as was accorded to the humblest and most mediocre manufacture of the land—a class to itself; but to class it with philosophical instruments, &c., is as ridiculous, and more out of place, than if the exquisitely artistic production of the Coventry looms had been heterogeneously intermingled with ceramic ware.

The result has proved just what every one expected; having been treated as an affair of no importance at the onset, the same depreciating treatment has characterized the whole matter up to the present time, and will do to the end of the chapter, a treatment which can only excite our unmitigated indignation.

Being a fraction of a class, and in the eyes of the Commissioners I should imagine, an uninteresting and invaluable fraction, it has accordingly a proportionately smaller fraction of the Jurors to decide upon the merits of the productions of its individual exhibitors, and this fraction (as though to add insult to injury), composed of the very men that ought never to have been appointed at all.

In my last I had occasion to dwell upon the reprehensible consequences which this arrangement has necessarily produced; discreditable to the jurors, and notoriously unjust to the exhibitors. It now remains for me to make some few animadvertory remarks relative to the exhibitors of deep sea cables, and how they have been treated; and this is so much the more surprising and important, inasmuch as the Jurors in this matter were *worse* than partial; they were either incompetent, or they did not, and cannot appreciate the importance of the most weighty and deservedly-interesting question of the day, notwithstanding the elaborate papers that are read on the subject before learned societies, which perhaps are only due to the vanity of theorists, who have, as well, their own interests to serve. Of course " 'Tis pleasant for to see one's name in print," and it doubtless adds to the pleasure, if it have first saluted the ears of a learned body. And this is a blissful distinction by the way, to which the excessive modesty of your present correspondent forbids him to aspire.

The failure of the Atlantic cable wrought disastrously upon the civilized world, whose earnest anticipations of its success were strained to tension point; and when I say thus much, I convey but a faint idea of the engrossing importance this project had upon the mind of the nations; but more especially does it apply to England and America. But this utter prostration of their most sanguine hopes by no means divested long sea telegraphs of their importance; and hence, although cast down, electricians, telegraph engineers, and cable manufacturers were not so far disheartened as to give the thing up in dispair; on the contrary, it assumed more importance if that were possible. All the skill, inventive faculties

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and practical knowledge the country could command, were brought to bear upon the question, with not, we should hope, an utterly futile result. A Government Committee was appointed, whose principal duty it was to elucidate the mystery, and establish beyond a doubt the feasibility of long and deep sea telegraphs; and I presume a question may be said to have assumed some little importance, when it excites the attention of the celestials who so obligingly condescend to govern us.

But in the eyes of Her Majesty's Commissioners, submarine telegraphy was even of less importance than Staffordshire crockery, or Mr. Doulton's drain pipes, and the electrical Jurors of Class XIII. very dutifully trod in the footsteps of these mighty dignitaries. Of course some people have a happy knack of seeing things from precisely the same point of view as their superiors—lucky men! what might not I have been now had the fates so blessed me in my mental optics. I pray you, my reader, cultivate this faculty if you have any regard for self-interest, and making your way in the world.

There has been one medal awarded for submarine cables, viz., to Messrs. Glass, Elliot, and Co. Conceding the award to be well merited, it is altogether apart from the matter to which we now have to do; the firm in question have not solved the problem of deep sea telegraphs, nor have they produced, or even projected, a cable that will meet the principal requirements of the case; hence the award rendered into simple English means that Messrs. Glass, Elliot, and Co. are awarded a medal for the successful application of their submarine telegraph cables *to shore ends and shallow waters*. As the award stands, however, it would convey the erroneous and absurd notion that this firm had been successful in every department of Old Neptune's demesne.

Mr. Henley's cable receives "honourable mention," but as it is on precisely the same principle as Messrs. Glass and Co., it has the same restricted application; both makes are too cumbrously heavy for long and deep seas; and, moreover, constructed upon a wrong principle, according to the humble and deferential opinion of your correspondent. There is one other cable, and only one, of which our electro-juridical trio deign to take any notice—Mr. Hooper's; this is certainly an attempt in the deep sea line, and a very creditable one, but there is too much metal about it, the compact sheathing of fine steel wires adds considerably to its weight; and then it possesses the serious defect of being applied with a slight spiral: and a metal sheathing of fine wire so applied is even more objectionable than when the wires are few in number but massive; of course its outer covering of vulcanized rubber serves to keep them in place. For this attempt Mr. Hooper receives an "honourable mention;" no one can find fault here, but I may be allowed to express some surprise that it should have been noticed at all since all the others were disregarded, some of which are manifestly superior.

We are at the end of the catalogue. There are some dozen exhibitors of submarine cables, among whom, as we have seen, are liberally scattered one medal! and two "honourable mentions"!! and yet, notwithstanding this unwonted munificence, the all-absorbing question of ocean telegraphy is not helped forward one bit, nor the problem in the least elucidated by this International Exhibition, in so far as the Commissioners and Jurors have had to do with it; and yet will it be said that among all the exhibitors of submarine cables, there is not one who deserves a medal for at least an approximation to the desired end? Fortunately, true merit in this line is likely to be appreciated and patronized regardless of the adverse influences of incompetent and partial jurors.

The cable exhibited by Mr. Allan appears peculiarly well adapted for deep seas, if its insulation had been of caoutchouc instead of gutta percha; apart from this, however, its principle of construction is good; it secures lightness with strength, and I should imagine, would be durable. But supposing this cable had been everything that could be desired, there was still another question of no trifling importance in the eyes of certain individuals, "Who is Mr. Allan, indeed?" Well, my dear sir, you have had one medal, and we have before descanted upon the circumstances thereof; impartial and appreciating Jurors must not be too lavish with their honours: so stand aside Mr. Allan.

A very ingeniously constructed cable is shown by Mr. Rogers, but I fear it would elongate considerably when subjected to strain. Never mind, the Company at Gresham House has a real live nobleman at its head, whose name, titles, and all attending paraphernalia can adorn the circular record of its transactions—patronage far more potent and desirable than this tint of hieroglyphic pewter—for nobody believes in the "cold shade of the aristocracy," none.

Not even Messrs. Siemens, Halske, and Co, bending under their weight of honours, nor yet Messrs. Silver and Co., with the advantage of powerful patronage, have any notice taken of their submarine cables, although the first-named gentlemen rather pique themselves upon having discovered the very thing wherewith to thread a highway or a lowway for the electric spark among the stables of the Hippocampi. Can I instance anything more confirmatory of the utter insignificance which deep sea telegraphs have in the estimation of the Jurors, than that the scaly cable of the one and the brazen-serpent-looking cable of the other should fail to excite the action of their organ of benevolence?

What moots it therefore if Messrs. Wells and Hall exhibit a cable eminently fitted to nestle in the depths among the Nereides, with the same gratifying results, it were unbecoming to exhibit any chagrin under such circumstances; and yet the cable in question is doubtless one of the best that has been constructed for the purpose, being of a light specific gravity and yet combining therewith extraordinary strength. Your readers are doubtless pretty familiar with this cable from the publicity already accorded to it; it may not, however, be out of place to notice one or two points which establish its claim to a high position among the cables that have been invented for deep seas. We have spoken of its light specific gravity (1·85). Its tensile strength renders it capable of bearing the enormous strain of upwards of 11,000 fathoms when suspended in sea water, hence its principle of construction must be good, and as a further proof of this, the cable shows but a very trifling elongation when subjected to breaking strain, and moreover will not shrink, at the same time it affords ample and efficient protection to the core. On my conscience, I believe this cable, or rather the patentees thereof, deserve a medal; the Juror, it seems, thought otherwise, or more probably did not trouble to think about it, perhaps did not see it. But rest ye contented good friends, have not you received "honourable mention" for your insulated wires, and would you have a medal for your cable also? how could you bear up under such accumulated honours? you surely would not have Pelion piled upon Ossa in this way? Deep sea cable, like everything else, must have its period of probation, and until the matter is more practically experimented upon, it will be impossible to arrive at any certainty as to what description of cable will be most suitable in every sense of the word; in the meantime, however, and lacking this, we are able, theoretically, to form some proximately correct idea as to its probable requirements, and although this is less satisfactory, it is by no means to be despised, and hence, when a cable is invented which combines all the good qualities required in our idea of a cable thus formed, it is surely entitled to approval and commendation, as a step in the right direction towards elucidating the doubtful matter we are all so anxious should be satisfactorily solved. I don't think any one would assert that there is no cable in Class B which is a commendable approximation to the required desideratum; and yet such is tacitly the verdict given by the Jurors of Class B. Will the public accept the verdict? I trow not.

Cable manufacturers and the public had a right to expect that this Exhibition, which will do so much towards stimulating to all that is progressively perfect in science, art, and manufacture, should have a like influence upon electrical and telegraphic science; but it will not have (or if it should, we shall not have the Commissioners nor the Jurors to thank), and thus we have presented to us the anomaly—the discreditable anomaly—of this science, this enterprise of ocean telegraphy, in which the gods might take an interest, utterly ignored. It may be fitly compared to a work of immortal and transcendent genius, destined to thrill the hearts of mankind down through the centuries to come, falling still-born from the press.

Momus.

To the Editor of The Electrician.

Sir,—Among the ship load of fine things which the Viceroy of Egypt takes back with him to the land of the Pharaohs, is a pair of single needle telegraph instruments, similar to those in possession of Her Majesty, which are used in the train when travelling for the purpose of communication, one carriage with the other. It is gratifying to hear of these mighty despots from the drowsy regions, being so far awake as to appreciate the practical applications of modern science.

It is supposed these instruments will be of great service to His Highness in the seraglio: one is to be placed in his own private bath-room, the other in the innermost sanctum of the harem, at which a eunuch will be stationed for the express purpose of informing His Serenity how his fair Circassians individually behave themselves when his August presence is temporarily withdrawn. They will also be devoted to the same use when the Viceroy and his houris go yachting up the Nile.

These instruments were made by Mr. C. V. Walker F.R.S., of Tunbridge; they are small and portable, and have some 30 yards, or so, of four-wire silk-covered cable permanently connected with each: the cable, I am led to understand, was manufactured by Messrs Wells and Hall; each wire is separately insulated with india rubber and afterwards served with a layer of cotton, each of a dfferent colour; and then by some peculiar process thrown together and nicely coated with green silk. The same parties also made the cable attached to Her Majesty's instruments as above referred to.

These instruments are elegant little things, and reflect the highest credit on Mr. Walker, for although the time in which to make them was very limited, they have been executed with the greatest care, and are as delicately perfect as they are beautiful.

The Turkish device and the Viceroy's manogram are on the dials.

Mr. Walker has been patronized by Royalty, home and foreign, which is certainly a nice little feather in his cap; it is a flattering proof that his abilities are appreciated in very satisfactory quarters: and I think it would have done no discredit to the Jurors of Class XIII. if they had awarded him a medal, instead of a paltry "honourable mention" for the very excellent instruments he exhibits, and which are certainly equal to the best in the exhibition, perhaps they thought Mr. Walker was already sufficiently honoured, and so very considerately laid it on as light as possible for fear of the ulterior consequences to Mr. W's. upper story.

July 29, 1862. T. J. S.

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To the Editor of The Electrician.

Dear Sir,—I am obliged by your answer to my inquiry, which indicates that if the wire was coiled on the arms of the permanent magnet, and the circuit opened and broken by an armature, the effort would not be so powerful as if the wire was coiled on an armature of iron, and then placed on the poles of the magnet, and the circuit of the magnet to be opened and closed by the iron armature on which the coils are placed.

As induced currents *can* be produced by making and breaking contact with a permanent magnet, will such currents, by being passed through an Electro magnet, cause magnetisim? if so, can you give me a reason why the contrivance I described; a short time back, should not act, as it would require but a small amount of power to draw down the long arm of the lever there described; if it is possible that the machine would act, the question of obtaining electricity cheaply is solved, for, it would not require any motive power to continue it in action,—putting aside the question of perpetual motion, the machine would certainly be self moving and self sustaining, and might be so constructed as to give a surplus of induced magneto currents. I shall be glad (if I am not troubling you too much) if you will give me a full opinion of it.—yours respectfully,

J. Cook.

[We will state some of the reasons, exclusive of considerations relating to the general laws of force, which induce us to think that the arrangement you suggest would be inactive. When we close the circuit of the permanent magnet, we produce, in the form of an induced current of electricity, a force equivalent to the difference of the magnetic polarity of an open and a closed magnet. This current is in the opposite direction to that which would be required to produce in a bar of soft iron a similar polarity to that of the permanent magnet. So far all is well for the operation of the machine; we may assume that, at the instant of the completion of the circuit of the permanent magnet, the attractive force of the armature is considerably weakened by the induced current. But this current, which partially destroys the effect of the permanent magnet, causes the temporary magnet, which may attract the other extremity of the lever, to *acquire* its magnetic polarity. We do not know the difference in the degree of magnetic polarity of an open and a closed magnet, and we cannot therefore give the data for calculating the relative attractive power of the permanent and the temporary magnet under the given conditions. But we know that *time* is required in the production of the maximum degree of magnetic polarity in a bar of soft iron by the action of the current. It is probable, therefore, that by the time the temporary magnet may have acquired its maximum of polarity, the permanent magnet may have assumed its full attractive power. But leaving this consideration out of the question, the fact that the armature of the permanent magnet will be *in contact*, while that of the temporary magnet will be at some distance from its poles, appears to be sufficient to show that continous motion would not be produced. Placing the armature of the temporary magnet upon the longest arm of the lever, is equivalent to increasing the distance between it and the poles of the magnet. The conditions we have referred to might doubtless be modified by coiling the temporary magnet with a greater length of wire than that in the coils of the permanent magnet; but there are several reasons, some of which you will doubtless perceive, why this plan should not be effective. In conclusion, we may point out that an oscillating lever is not adopted for the effort of rapid vibration, such as would take place by the alternate operation of the magnetic forces, supposing them to be efficient for the purpose in view. We do not wish to dissuade you from constructing the machine, which might possibly bring to light some new and interesting facts in connection with magneto-electric induction; but, in accordance with your wish, we have pointed out the reasons which, in our estimation, would negative the solution you suggest for the ancient problem of the *perpetuum mobile*. [The description of the contrivance referred to will be found p. 251 Vol. I.—Ed. E.]

RAILWAY SIGNAL TELEGRAPHS.

To the Editor of The Electrician.

Sir,—A very interesting and instructive discussion upon the above important subject, took place in your columns in the early part of this year, which myself and many others, deeply interested in the safety of railway travelling, thought terminated rather too abruptly, as the subject was by no means exhausted. There is reason to believe that the absence of a simple and efficient signal telegraph for railway purposes has been the cause of the sacrifice of much valuable life and property. At the Kensington Palace there are two or three different contrivances exhibited for avoiding, to a greater or less extent, the recurrence of these melancholy accidents. I may mention Mr. C. V. Walker, F.R.S., Mr. Tyer, and Mr. Eugene Vicenzi, but in the "Book of the Awards" I have looked in vain for a deserving recognition of those gentlemen's humane efforts to lessen the dire casualties of railway travelling, with the exception of an "honourable mention" awarded to Mr. C. V. Walker, F.R.S. Can it be possible that the gentlemen entrusted with the decision as to the merits of the exhibited contrivances for so important a purpose, could have passed over and ignored those which emanated from individuals who had not the good fortune to be fellow members of the Royal Society? Let the unbiassed public examine and judge for itself as to the relative merit and efficiency of the instruments exhibited for the above purpose in Class 13.

Yours &c., Orlando.

To the Editor of The Electrician.

Sir,—I was much surprised to see an article in your journal of July 25, headed "On the Electrical Qualifications requisite in long Submarine Cables, by the *late* Samuel Alfred Varley," and to find it was an extract of mine, read before the Institution of Civil Engineers, on the 30th of March, 1858, and published in the "Transactions" of that Institution.

I beg to inform you that I am still alive, and I hope you will insert this letter to rectify the mistake.

I feel it only due to myself to remind you that the paper was written previous to the submergence of the Atlantic Telegraph, at a time when the belief that small conductors were more efficient than larger ones for submarine circuits had numerous supporters.

Since then the whole subject has been investigated by a Government Commission, and numerous experiments tried at the public expense, increasing our knowledge considerably.

I must consider it a compliment to republish a paper of mine, but it is not fair to give only a part, and I really must ask you *now* to complete it.

At the time the paper was read I was conscious of its shortcomings; to supply these in some degree I read another paper on the 30th of March of the year following, before the Society of Arts, a copy of which I enclose, as I consider the second paper a part of the first. I would feel obliged, should your space permit, by your publishing it also.—I am, sir, your obedient servant, S. Alfred Varley, Assoc. I.C.E.

7, York Place, Kentish Town, N.W., July 29, 1862.

[By an unfortunate misapprehension, the name of Mr. S. A. Varley was confounded with that of his brother, Mr. C. J. Varley, whose early decease is specially to be regretted from the point of view of telegraphic science. The general accuracy of the conclusions arrived at in the paper from which we gave the extract referred to, renders this paper a most valuable contribution to the literature of telegraphy; but its interest is enhanced by the fact that it was written at a period when the most erroneous views were prevalent on the subject of the fundamental laws on which the construction of submarine lines should be based. We have, therefore, every inducement to comply with the request of Mr. S. A. Varley, contained in the above letter, and we shall be glad to do so at an early date.—Ed. E.]

Miscellanea.

The Viceroy of Egypt.—Mr. Eborall, the general manager of the South-Eastern Railway, with Mr. C. P. Walker, telegraph engineer to the company, attended on Thursday last on board the viceroyal yacht, at Woolwich, to deliver to his Highness, the Viceroy, a pair of royal special telegraph instruments, which have just been constructed in the telegraph department, on the same plan as the instrument which is carried in all the royal special trains on the railway. The Viceroy minutely inspected the specialities of the apparatus, which were explained in detail by Mr. Walker. The instruments, it may be mentioned, were made within a fortnight at the telegraph works, Tunbridge. They are small, portable single needles, with thirty yards of thin silk-covered multiple cable, manufactured by Messrs. Hall and Wells attached to each; and are intended to enable communication to be opened on emergency with any station. The arms and monogram of the Viceroy are on the dials. They are contained in handsomely polished cases, each case bearing the name and device of his Highness on a silver shield. The Viceroy having expressed a wish to see the nature of the Instrument, a "voltaic" was improvised and attached, in the absence of the pocket poles that are in preparation.

The Directors of the Electric and International Telegraph Company have resolved to recommend to the proprietors at the general meeting on the 5th of August to confirm a dividend of £3 10s. per cent. for the last half-year.

To Correspondents.

K. R. U.—3. The cyanide salt will separate the oxide of gold from the magnesia employed to effect its precipitation. The atomic equivalent of gold is 98, that of magnesia 20·16. These numbers will guide you as to the proportion of magnesia it is requisite to use; but it is safest to employ a considerable excess of the earth, as this is seldom to be obtained in a state of absolute purity. Say 24 magnesia to 98 of gold dissolved. 4. We think that there is room for profitable enterprise in the direction you point out. Plates of gas-carbon, if cheap and readily procurable, would be far more extensively used than at present in the construction of batteries.

R. D.—We certainly should wish to give our readers more information as to what is going on in the telegraphic world—in fact, to make the Electrician, as you say, more "newsy;" but as everybody wishes for information, and few are inclined to give it, you will see that, under the circumstances, although there is the "will," the "way" may be sometimes wanting.

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The Electrician.

VOL. II. No. 40.—AUGUST 8, 1862.

CONTENTS:

	PAGE		PAGE
Animal "Magnetism"	157	Report of the Electric and International Telegraph Company	165
Some Considerations on the Principles of Electrical Conduction and Accumulation	158	Prices Current of Insulating Materials	167
On the Periods Occupied in Charging Different Lengths of Telegraph Wire	160	Telegraph Shares	167
On Railway Telegraphs	162	Recent Patents	167
The Sulphate of Lead Battery of M. Becquerel	164	Telegraphic News	167
On Some New Phenomena, &c.	164	Correspondence	167
		Miscellanea	168
		To Correspondents	168

ANIMAL "MAGNETISM."

WE are about to touch upon a subject which may lead us for a few moments upon what has been, and is, considered by scientific orthodoxy as forbidden ground. Some of our readers may smile at the assertion that we consider the basis of the *quasi* science of animal magnetism, viz: the production of a variety of effects upon animal organisms by the direct action of the will, operating through an apparently immaterial principle, to be a fact established beyond dispute and easily verified by all. It is not our purpose, however, to enter into the discussion or elucidation of these most astounding, though, to many, familiar phenomena; but briefly to examine whether the connection which is implied to exist between magnetism, and the agency in the effects observed by MESMER, has any foundation in fact. If such connection could be traced, and carefully substantiated by experiment, there would be some prospect of finding, one by one, the links of a chain uniting what is already accepted by science, with phenomena which, owing to their isolation from the series of facts which are verified by theory as well as by experiment, and also to their extraordinary character and occult nature, are held to be unknown. It is a characteristic of modern science, due principally to the influence of an academic organization by which *reputation* is bestowed or refused, that the discovery of a fact isolated from previously known phenomena, and involving conclusions for which scientific orthodoxy may "not be prepared," is certain to be rejected or ignored. As peculiarly pertaining to our own general subject matter, we may instance the discovery of the fact that *electricity possesses weight*, arrived at many years ago by one of the present contributors to our columns, and based upon experiments which are allowed to admit of no other interpretation. It is probable that few of our readers have ever heard either of the discovery or of the experiments by which it was substantiated; and the explanation is simply that the *Academie des Sciences* of France were not "prepared" either to receive, or to disprove them, and preferred to ignore the subject indefinitely, or until the results obtained might be more in accordance with accepted doctrine. It was probably concluded that our learned bodies in England, which, we need scarcely observe, are made up of individuals, would be equally indisposed to recognize a conclusion at variance with, and to some extent stultifying, views to which, individually and collectively, they had given their sanction and authority. Be this as it may, the ponderable nature of electricity was left, as far as received opinions are concerned, a question solved only in the assumption which classes electricity as "one of the imponderable principles."

For our own part, we may observe, although we appreciate in many cases the cautious reserve by which science is confined to a path which leads onwards inductively, by certain and secure gradations, from what is known to what in natural sequence is next to be investigated; we hold ourselves at liberty to recognize facts, however obnoxious to scientific orthodoxy, whenever and wherever they may present themselves for our consideration. We have little fear of sacrificing reputation based upon a conventional standard in the cause of the truth we know or believe. Still less do we fear to encounter the weapons with which presumptuous ignorance, supported in some degree by the indifference or the prejudice of scientific authorities, commonly assails facts which are beyond the ordinary scope of experience, and which it has not the capacity either to recognize or to disprove by candid and careful examination.

It was imagined by THALES and ANAXAGORAS, that the magnet was possessed of an immaterial spirit, under the influence of which iron became attracted. According to COSTEO DE LODI, the effect of attraction was in this case peculiarly active, because iron "constitutes the natural food of the magnet;" but several of the ancient philosophers, whom we may suppose to have been more or less acquainted with the physiological phenomena studied by MESMER, adopt the less glaringly absurd hypothesis of a magnetic "sympathy." Among the alchymists, from GEBER to VAN HELMONT, it appears to have been a favourite idea that all bodies, or at least certain classes of bodies, were physically of the same substance, but were endowed with different spiritual essences, or principles of being, upon which their various properties were made to depend; these principles being analogous to that which gives to the magnet its attractive power. We have here the leading idea upon which was based the belief in the possibility of transmutation. The same notion is prevalent throughout the writings of JACOB BEHMN, in whose system of philosophy every body, animate or inanimate, is held to be possessed of an immaterial principle of being, subject to certain trancendental laws of nature, and susceptible of being influenced by the will.

It is easy, therefore, to account for the term animal *magnetism* applied to the *vis vitæ* assumed to be the agency through which matter is affected by means of a cerebral organization, without necessarily supposing that any real analogy was discovered between this force and that which is evidenced in the magnet. It is probable that the term magnetism was intended merely to express the idea of extreme tenuity or intangibility. From a very early date, magnetism, acting silently and without disruptive effect, even through substances which prevent the passage of electricity, was held to be a more "subtile principle" than the latter. The expression, animal "magnetism," was, however, in accordance with the philosophical ideas which were prevalent when the phenomena were first publicly made known and examined. If the comparatively recent researches of REICHENBACH receive confirmation, the term would appear singularly well chosen. It is to be observed that the conclusion which FARADAY has confirmed, that all bodies are subject to the action of magnetism, although but few exhibit under its influence an attractive force, was very generally entertained by the early writers treating of this force.

It is at all times a most difficult task to separate, from the mass of unfounded and often absurd assumptions of writers and thinkers who have not been guided by the Baconian system of inductive reasoning, any views which may be founded on a combination of observed facts, and which may, therefore, approximate more or less to truth. To the modern disciple of science the necessary investigation is in most cases a practical impossibility; for, as PALEY justly observes, "contempt before inquiry is fatal." Many of those, however, who are most eager to fathom Nature's secrets, have found in the speculations of the old philosophers, who followed in the track of ARISTOTLE, a mine of suggestions, among which some few have amply repaid the labour of examining the "wondrous guess-work" of these thinkers. In some cases they may have roughly paved the way for the ultimate extension of our more exact system of scientific research. They attempted to exhaust the whole *systema naturæ*, and the explanations they furnished should be examined by those who have the ambition to improve upon them. Modern science has, in many instances, taken its starting-point from their mystical suggestions. It was to discover the proximate cause of vitality, the principle which gives life to an organism, that GALVANI

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enthusiastically followed his invaluable researches. Already, in the year 1700 it was known to Du Verney that the limbs of a frog are convulsed by the action of electricity. Swedenborg, in 1734, had insisted upon the close relationship between electricity, magetism, and other polar forces, among which was classed that of vitality. Galvani, as we know, did not find the proximate cause of physiological action; but discovered the "electricity of metals," and found in his prepared frog a most sensitive galvanometer. Thenceforth, for a long period electricity was considered as the vital force. The subject of animal electricity has been most carefully studied, and the existence of an electric current from the muscles to the nerves, has been verified by Nobili and other experimenters. But it is sufficiently obvious that nervous force is not electricity; and it would, indeed, be extraordinary if the chemical changes constantly being effected in the animal system produced no more manifestation of force than pieces of silver and zinc, scarcely recognizable by the unassisted eye, and excited by a single drop of water. It is not without reason, therefore, that nervous force was regarded as analogous to magnetism rather than to electricity. The function of the latter in the animal economy appears to be merely the production of a condition of irritability, under which nervous force becomes manifested. Dr. Golding Bird affirms that "it is quite indisputable that the human body is always in an electric state, but of the feeblest tension, never exceeding that evolved by the contact of a plate of zinc with one of copper. It increases with the irritability of the person, and appears to be greater in the evening than in the morning, disappearing altogether in very cold weather."

Ignoring altogether the existence of a branch of experimental research in which the vital agency distributed by the brain may be studied in various abnormal effects, writers upon animal electricity have sometimes, not unaccountably, arrived at the conclusion that nervous force is beyond the sphere of human investigation. Thus the author of one of the best known works upon "Human Electricity," states:—"We may safely say that electricity is an appendage to life in its innumerable forms, and that wherever there is life, as far as it is at present cognizable to us, there is also electricity. But after all we may do or say, life is beyond the reach of the most exalted human intelligence. Vital force in its lowest development is infinitely superior to electricity in its highest manifestations; and it requires no great penetration to perceive subtle powers which are not yet 'dreamed of in our philosophy,' beyond those physical forces with which we are yet so imperfectly acquainted, and these still inferior to that approach to spiritualism which we call life."* With a reasonable amount of deference to this conclusion, we conceive that the writer of the above has placed the question in a wrong light. *Life* we consider is the result of agreement and harmony in the essential functions of an organism; but the active principle by which these functions are performed may possibly approach no nearer to "spiritualism" than either electric or magnetic force, and, if properly studied, may equally be investigated. Let us compare the above passage with one by our most distinguished organic chemist:—"In regard to the nature and essence of the vital force, we can hardly deceive ourselves when we reflect that it behaves in all its manifestations exactly like other natural forces, that it is devoid of consciousness or of volition, and is subject to the action of a blister."†

We have yet briefly to advert to the apparent analogy or connection between magnetism and nervous force which has been studied by Baron Reichenbach. The previously ascertained action of the magnet upon the human system, more especially in the case of those persons whose nervous organization is peculiarly sensitive to external expressions, was carefully examined and verified by this physiologist upon a considerable number of persons. This action is similar to that which may be exerted by mesmeric passes, and appears also to be possessed, in a high degree, by certain crystalline bodies. Reichenbach conceived the idea of constructing a room, carefully guarded against the entrance of any external light, for the purpose of ascertaining whether the sources of these effects were possessed of any luminous manifestations. A number of persons separately and successively introduced within this room uniformly perceived an emanation of light of various tints from the magnet. The fact of this appearance was confirmed, as far as the experimenter was concerned, beyond the possibility of reasonable doubt. In order to verify it to others, who might consider this appearance as illusory, the experiment was tried whether the magnet might not, in an absolutely dark room, produce its own image upon a Daguerreotype plate. This experiment was perfectly successful. But the most extraordinary fact is, that a similar emanation was perceived by "sensitives," from the extremities of the fingers, the eye, &c., of persons who were capable of influencing them by the operation of the will. An intimate relation thus would seem to exist between magnetism and light, and between magnetism and what Reichenbach designates as the "odic fluid," a principle which appears to pervade the animal organism, to operate in accordance with the voluntary or involuntary impulse of the brain, and to be subject, in a greater or less degree, to influences residing in matter. This relation appears to us to be well worthy of further investigation on the part of those who are qualified for the research, and who are not deterred from such inquiry by the somewhat startling character of the results involved.

* *British Quarterly Review*, No. xxxv., p. 108. J. O. N. Rutter, F.R.A.S.
† Justus Liebig. *Animal Chemistry*.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 146].

When two insulated spheres in proximity to one another, and separated only by a dielectric, are charged with similar electricity, a force is produced tending to separate them, which is considered by some philosophers as the result of a repulsive action between the particles of the electricity with which the spheres are charged. The phenomenon may, however, be equally well accounted for, on the hypothesis, held by other men of eminence in science, that the electricity on the spheres is attracted towards the equal and opposite state which must exist on the nearest conducting surfaces to the spheres. Thus, the electricity on each sphere is attracted in such directions except in the direction of the other sphere, that the resultants of all these forces constitute two opposite forces tending to draw each sphere from the other.

The latter hypothesis is the one that appears to me by far the most in accord with general results, and by which I shall therefore attempt the explanation of certain effects.

The relation of quantity to this apparent repulsive force, is found to follow the same law as that which exists between quantity and the attractive force between oppositely electrified bodies.

Thus, by Coulomb's experiments, if the insulated spheres be kept at a constant distance, and at a constant and considerable distance from surrounding objects, and charged with equal quantities of similar electricity, and the force with which they tend to separate measured, then, if the quantity is doubled on both, the force will be quadrupled, if the quantity is trebled, the force will be increased to nine times its first amount, and so on; or, in fact, the apparent repulsive force varies as the product of the quantities on the two balls, or, what is the same thing, as the square of the quantity on one.

Coulomb further shows that, within the limits he experimented on, the repulsive force varied sensibly as the product of the quantities, whether equal or unequal, and inversely as the square of the distance separating the spheres. The objections I have suggested to the generality of the law deduced from these results with regard to similar results, only with attractive force, would

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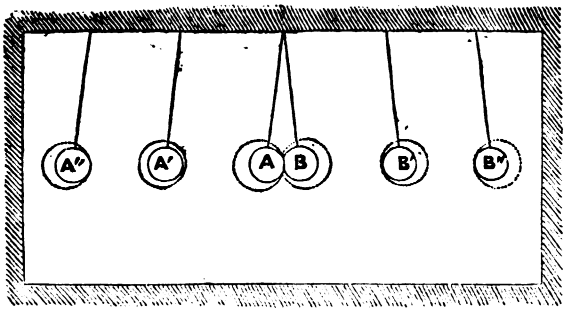
apply equally in this case. The repulsive, force when one sphere is uncharged should, according to Coulumb's law, become zero, and it should not become zero until one of the spheres is uncharged. Whereas we know that if a sphere is strongly charged, and another sphere charged with a very small quantity of the same electricity, that *attraction* between the two spheres may result.

The alteration in the apparent repulsive force when the distance is altered can be shown, may result from the re-distribution, which must occur, and this redistribution would take place according to the alteration in the inductive resistances in different directions.

Thus, when the spheres A and B (fig. 84) are charged with similar electricity, the distribution will be such, that no electricity will exist at their point of contact, little at the points near it, and will be at its maximum at the points opposite to the point

Fig. 84.



of contact. The attraction between the quantity on each sphere and its opposite state on the surrounding conductors would, therefore, constitute a series of forces, the resultant of which would be a force attracting each sphere away from the other. If the spheres are then separated, a redistribution of the electricity on each side will result, the distribution becoming more uniform, if the surrounding objects are distant, and the attractions between the charge on each sphere and its opposite state on the surrounding conductors will be more equally distributed in every direction; the resultant of these attractions will therefore constitute a force, still tending to separate the spheres, but smaller than before. If the spheres are now brought near to the surrounding objects, as at A″ and B″, the distribution on them will become again greatest on their sides, the most remote from the other sphere, and consequently the force of apparent repulsion will increase.

If the surrounding conducting surface, on which the opposite state must exist, is altered, it is evident, from what has been previously shown with regard to distribution, that such a redistribution may be produced as to cause a change in the apparent repulsive force,* without the distance between the spheres being altered.

If two equal conducting spheres B, B′, Fig 85, are freely suspended from a point of suspension, on an insulated support, by small conducting rods, and electricity communicated to them, it is evident that the two spheres and suspending rods will share the charge between them, and mutual repulsion between the spheres will result; the balls will therefore diverge to a certain amount. If the quantity is increased the divergence will increase, and if decreased, the divergence will also decrease.

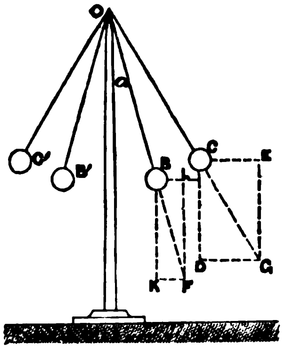
The degree of repulsive force exerted between similarly charged bodies free to move being, therefore, evidently related to the quantity of electricity communicated to them, has, from the earliest periods of electrical research, formed a rough mode of ascertaining the increase or decrease of the quantity of electricity communicated to them under various circumstances, and consequently of comparing indirectly the electrical state of other bodies brought into contact with any given arrangement, such as two gold leaves, or two suspended pith balls.

If we suppose all the surrounding objects constantly in the same position, then, it is evident, a change in the divergence between the arms of such an arrangement will indicate a change in the quantity on the instrument, and the relation of the divergence to the quantity causing it becomes an interesting problem. If the surrounding objects are so close to the instrument that any change in the divergence materially alters the inductive resistance between the instrument and the surrounding surface, then the conditions would become so complicated and indefinite, that it would be impossible to lay down any general relation between the angle of divergence and the quantity on the suspended arms. But if the surrounding objects are at a great and constant distance, then, by the laws regarding the relation of the repulsive force to the qauntity and distance as found by Coulomb, for small spheres, we may arrive at the relation between the angle formed and the quantity causing the divergence.

Let us first investigate the case of an electroscope composed of two suspended equal and moveable arms, such as that represented in fig. 85.

For this purpose, we must consider the arms, by which the spheres are suspended, of so small surface, that their capacity

Fig. 85



for charge may be considered indefinitely small as compared to the spheres, then we may consider the force as a repulsive force, practically exerted only between the spheres. This force, according to Coulomb, decreases as the square of the distance between the spheres, and increases as the product of the quantity on them. But by the nature of the instrument, the quantities on the two spheres are constantly equal; therefore, the repulsive force increases as the square of the quantity on one sphere; and as the quantity on one sphere bears constantly the same proportion to the whole quantity on the instrument, we may state the general relations between distance, quantity, and force, by the formula :—

$$F = \frac{Q^2}{D^2} \qquad (1.)$$

where F = force with which the spheres are repelled from on another;
Q = the quantity;
D = the distance between the centres of the spheres;

and from this we get—

$$Q = \sqrt[2]{F\ D^2} \qquad (2.)$$

Now, to diverge each arm to any angle, *a*, with the vertical, the resultant of the force of gravity, and of the repulsive force exerted between the balls, must evidently pass through the point of suspension, *o*, in order to produce equilibrium. Thus, if the balls are diverged to B and B′, then if B K represent the force of gravity acting on B, then B L, or B′ B produced, will be the direction of the repulsive

* The whole subject of the repulsive force between two insulated spheres or discs, (the one fixed and the other moveable) charged with the same electricity, and the way that force may be varied in degree by approaching uninsulated bodies to them in different directions, form a series of interesting problems, but into which it is impossible for me to enter, on account of the number of wood cuts that would be required to illustrate the subject properly.

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force between B and B′, which constitutes a force similar to that which would be produced by a force pulling B towards L. B L must be of such a magnitude, therefore, that the resultant (B F) of the force B L and B K shall lay in one straight line with O B. In the same way, taking the spheres in some other position, C and C′, then, taking C D = B K to represent the force of gravity, C E = the repulsive force. Now, taking B K as radius, F K (= B L) is the tangent of the angle F B K. And taking C D as radius, D G (= C E) = the tangent of the angle G C D. And since B K and C D are equal, the forces B L and C E are to one another as the tangents of the angles F B K and G C D; and the same may be proved of the relation between any other angles and the force required to produce them. But these are the angles formed by the arm B O with the vertical; therefore, the force diverging the arms of the instrument is as the tangent of the angle (a) formed by one arm with the vertical.

F, in equation 2, is, therefore, proportional to the tangent of the angle a, or angle formed by one arm with the vertical.

Now the distance D, between the centres of the spheres, it will be seen, is proportional to twice the sine of the angle a.

Therefore, substituting for F and D, in equation 2, the trigonometrical functions to which they are proportional, we get the formula

$$Q = \sqrt[2]{\text{tang. of } a \times (2 \text{ sine of } a)^2}$$

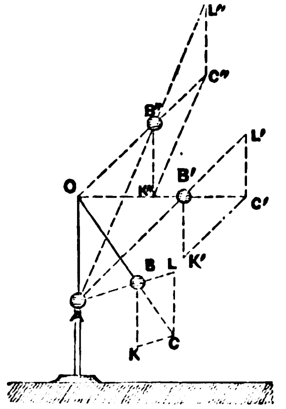
where Q = quantity
a = angle of one arm with the vertical.

In this instrument, the divergence of one arm from the vertical can never reach 90°, for since the force of gravity is constantly acting at right angles to the repulsive force, it is evident, since their resultant must always fall between the two, it can never make so great an angle as 90° with the direction of gravity, *i. e.* the vertical, for in such case it would no longer fall between the two but on the other.

Consequently, theoretically, the quantity that can be measured by this instrument is infinite. Practically, however, the increase of the angle of divergence passed 50° or 60° must soon bear such a small ratio to the increase in quantity, that it must form a very inaccurate measure.

If the electroscope is made with one fixed and vertical, and one moveable arm, as in figure 86, the problem is different.

Fig. 86.



To diverge the arm and sphere B to an angle B O A, by the force exerted between B and A, the repulsive force must be such that its resultant with the force of gravity shall also pass through O. Let B K represent the force of gravity. The repulsive force between A and B will be in the direction B L; drawing, therefore, K C parallel to A B and producing O B to C, and completing the parallelogram K B L C, we get B L the force with which the spheres must repel one another to cause the arm to diverge to B. In the same way, the force required to diverge the moveable arm to B′ will be B′ L′; and to diverge it to B″, will be B″ L″.

But it can easily be demonstrated, by similar triangles, that the forces B L, B′ L′, and B″ L″, are to one another as the chords A B, A B′, and A B″ of the angles subtended by the two arms of the instrument. The force required to diverge the arm to any angle from the vertical, is therefore as the chord of that angle.

Therefore F, in equation 2, is proportional to the chord of the angle of divergence or angle a. And it will be seen that D, the distance between the spheres, is also proportional to the chord of the angle a, therefore

$$F = \text{chord of } a$$
$$D = \text{chord of } a$$

therefore

$$Q = \sqrt[2]{\text{chord of } a \times (\text{chord of } a)^2}$$

or

$$Q = \sqrt[2]{(\text{chord of } a)^3}$$

In this instrument, when the quantity is such that its repellant force at a distance equal to double the length of one arm, is equal to the force of gravity, the moveable arm will diverge to 180°, that is, it will stand up over the other ball, and any further quantity could, therefore, produce no effect on the instrument. Consequently, the quantity that can be measured has its limits, which will depend on the weight of the moveable arm and its length.

(To be continued.)

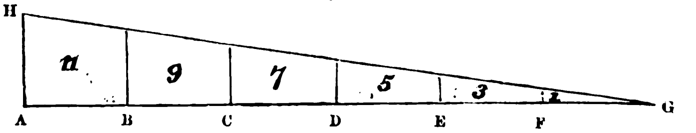
ON THE PERIODS OCCUPIED IN CHARGING DIFFERENT LENGTHS OF TELEGRAPH WIRE, WHEN THEIR DISTANT ENDS ARE TO EARTH.

BY RICHARD LAMING, M.R.C.S.
AUTHOR OF "STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY."

No apology is necessary for accepting the liberal offer of his own pages made by the Editor of The Electrician for the discussion of all electrical doctrine from time to time appearing in them, without claimed exemption being in favour of official articles. When opinions are put forward professedly for the teaching of the public, those opinions ought, I think, to submit themselves at every step they take to public criticism, without either seeking refuge under authority *of any kind*, or claiming for themselves the dangerous prerogative of building up, it may be in opposition to truth, what truth may afterwards find it tedious to pull down. I am applying this remark generally, for in the present instance, though I shall differ in my method from The Electrician, I have the pleasure of perceiving that mine only establishes more perfectly the result to which his has closely approximated in the leading articles now in course of appearing.

Mr. Latimer Clark, by a well conceived and apparently well executed series of experiments which he has recorded as an appendix to the Report of The Submarine Telegraph Committee (section 26), proved that "if the whole length of any submarine cable be conceived to be divided into any number of equal parts, the quantity of electricity stored up in each section will be in the ratio of 1, 3, 5, 7, 9, 11, &c." (section 144), the cable being charged by any voltaic battery while its distant end is connected with earth. And this, it will be remembered, he represents geometrically by the following diagram,

Fig. 1.



in which A G is a submarine wire with a current flowing through it from A, where it enters, to G, where it passes away to earth;

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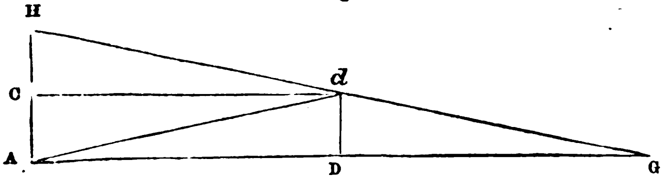
the perpendiculars raised upon the wire at the points A, B, C, D, E, F, all being equidistant from one another, and terminating in the line H G, divide the triangle into six parts whose areas are relatively as the numbers marked within them, and which express the relative quantities of charge resting upon the different sections of the wire, respectively.

The Electrician adopts the practical conclusion of Mr. Clark, and employs the diagram for the purpose of deducing the comparative periods of time occupied in separately charging two wires of unequal length, one represented by A D, and the other, twice as long, by A G. The periods occupied in the charge of similar wires have been pronounced by some mathematicians to vary in the ratio of the squares of their lengths; but to that ratio the articles in question take a preliminary objection on the plea that the inequality of the distribution appears to be disregarded; and they proceed to support the objection by a mode of analysis which has given the ratio for times of charging a double and a single length of wire of 28 : 91, instead of 5 : 20 as they are alleged to be.

The true ratio for two wires, one of them twice the length of the other, may be deduced by geometrically tracing the course of each individual particle, or unit of electricity, constituting their respective charges, as represented by Mr. Clark; that is to say, if by *true* ratio we are to understand that which alone is in exact accordance with observation. By the principles I have elsewhere inculcated, each particle of electricity passing entirely through a wire of given length, is checked by inertia at each particle of metal in the line which is conducting it from one end of the wire to the other end. My theory may be in abeyance, waiting due investigation; but that does not in the least affect the present question; for let the cause be what I have shown it to be or not, the fact is the same, and we have it indisputably established, that electricity, in passing through a given wire, experiences a resistance of some kind that is exactly commensurate with its length. From that it follows, that the hindrance to the electrical charge of a given wire of any length, must be as the sum total of the units of quantity in the charge, multiplied, respectively, by the distance each of them has to travel; and I need hardly add, that the time occupied by the hindrance, whatever be its nature, or its name, is, of course, measurable by the amount of the hindrance itself.

We will first calculate the relative times that will be taken to charge the two halves of any given wire.

Fig. 2.

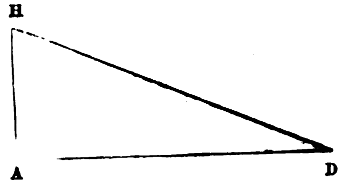


Let D be the middle point of a wire A D G, and A H the quantity of electricity steadily maintained constant at the battery end, A, of the wire, that quantity falling away to nothing at the point G. Divide A H G into four equal triangles by the lines D *d*, *d* C, and *d* A; then three-fourths of the quantity of charge will be seen to fall to the half wire A D, and one-fourth to the half wire D G.

Conceive the parallelogram A D *d* C to be divided into eleven equal parts by horizontal lines extended between the perpendiculars A C and D *d*, each part representing an unit of charge; and let those parts be subdivided each into 100 fractions, by vertical lines extended from C *d* to A D, each subdivision representing an unit of length on the wire A D. Then, taking half the length of that wire $= \frac{100}{2}$ as the mean distance passed through by each unit of charge, we have $11 \times 50 = 550$ as the time occupied in charging the parallelogram A D *d* C. Divide the triangle C H *d*, C H being equal to A C, into eleven equal parts by lines parallel to C *d*, and terminating in the line H *d*; then, their mean length being 50, and the mean distance passed through by each unit of charge $\frac{50}{2}$, we have $11 \times 25 = 275$, thus making the total time for charging A D to be $550 + 275 = 825$ units. On like reasoning, the time for D G will be 275 units for the triangle D *d* G; and to that add $\frac{11}{2} \times 100 = 550$ units occupied by the charge of D G in passing through the *whole* length of A D, making a total for D G of 825 units; and for the wire A G, of 1650 units.

We have next to calculate, in a similar manner, the time occupied in charging, from the same source, a wire of only half the length of the former one.

Fig. 3.



In this case we have the same quantity of electricity at A, denoted by an equal perpendicular A H, that quantity progressively falling to *nil* at the earth end, D, of the wire A D. Divide, as before, the whole of A H into 22 equal parts by lines parallel to A D, and terminating in H D, to represent units of charge; their mean length being 50, and the mean distance passed through by each unit of charge $\frac{50}{2}$ we have $22 \times 25 = 550$ for the time occupied in charging the wire A D.

As $1^2 : 2^2 :: 550 : 2200$, but instead of the latter number, as required by the law of squares, we have only 1650. But $1650 : 550 :: 3 : 1$. Now compare with this a quotation I will make from The Electrician of last week: "the experimental results obtained by Sir Charles Bright and Mr. Edward B Bright, and described in a paper read in 1854 before the British Association at Liverpool, appear to furnish tolerably correct data in regard to the comparative periods of charge of single and double lengths of wire. With 500 miles it was found that one-third of a second elapsed between the contact at one end and the maximum effect at the other extremity, and that with 1000 miles of the same wire, the retardation was one second."

Thus, then, the accordance between calculation and experiment is complete, and we have no reason to suppose it accidental; indeed any one acquainted with the laws of conduction, (see Electrician No. 30, p. 38), and the series of observations and reasoning from which those laws were ultimately derived, must have been fully aware that the law of the squares of the lengths for the times of charging uninsulated electro-telegraph wires is purely a myth, albeit it is said to have been demonstrated by the highest analysis—on what data does not appear, and that is important. A mathematical Archimedes with a *suitable* fulcrum and with algebra for his lever might lift a world of truth out of its right place, just as easily as into it, *all* reasoning needs to be well founded, as much as properly conducted.

By continuing the above method of calculation to a triple a quadruple and a quintuple lengths of wire, the times do not observe an uniform rate of increase, as the five lengths give a series varying as 550, 1650, 3483⅓, 6050, and 9350, or 1, 3, 6⅓, 11 and 17; but the following remarkable result comes out: the time occupied is greatest at the middle of each wire, and diminisshes in the same ratio towards its two extremities.

The expression "maximum effect,"* in the quotation I have made, renders it doubtful whether, in the experiments of the

* This refers to the effect upon a galvanometer, the full deflection of which occurs only when the wire is completely charged. In the experiments in question, the distant ends of the wires were led to earth.—Ed. E.

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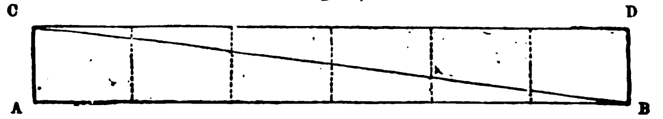
Messrs. Bright, the further ends of their wires were not insulated, instead of being put to earth; and such a difference would destroy the agreement between my calculations and their experience. I have referred in vain to the report published by the British Association, whose official "abstracts" of communications, in separating for publication the cream from the "etherial cloudiness" are sometimes known to leave the former in the dairy while the latter only is duly circulated for the advancement of science; the subject needed for the present occasion is altogether omitted. The difference, however, is of vital importance, because the same method of calculation applied to insulated wires gives, for unequal lengths, times for charging that vary as the squares of the lengths, as in conclusion I will proceed to show.

Fig 4.



Let the wire A B be connected with the battery at A, and insulated from the earth at B; then, instead of the triangle A B C, the parallelogram A B D C will represent the charge of the wire, which will be equal in quantity at every part of its length. Divide the parallelogram, as before, into eleven equal parts, by lines extended between the perpendiculars A C and B D, to represent units of charge; and suppose each of these parts to be subdivided into 600 fractions, each fraction representing an unit of the wire's length, say a mile. We shall have for the time occupied in charging the first 100 miles 11 × 50 (the latter being the mean distance each unit of charge will have to travel) = 550. For the second 100 miles we shall first have, on the same reasoning as before, 550 + (11 × 100 = 1100) = 1,650. For the third 550 + (11 × 200 = 2,200) = 2,750. For the fourth 550 + (11 × 300 = 3,300) = 3,850. For the fifth 550 + (11 × 400 = 440) = 4,950. For the sixth 550 + (11 × 500 = 5,500) = 6,050. And therefore the relative times for single, double, triple, &c., lengths of wire will be as 550, 2,200, 4,950, 8,800, 19,800, that is as 1, 4, 9, 16, 25, and 36.

ON RAILWAY TELEGRAPHS.

BY W. H. PREECE, ASSOC. INST. C.E.

Two very able papers on "Railway Accidents" were recently read at the Institution of Civil Engineers, the one by Capt. Galton, Assoc. Inst. C.E., and the other by Mr. Brunlees, M. Inst. C.E. Interesting statistical tables were introduced by each author, proving unquestionably that the great majority of accidents were attributable to preventable causes. Of these preventable accidents, 27 per cent. were shown to be due to a want of the electric telegraph. The papers, however, omitted to enter into any description, or express any opinion, upon the various methods and mechanical arrangements adopted on different lines to supply this desideratum, the want of which has been proved to be so disastrous. It is intended to supply this deficiency in the present article.

There are people who assert that the authors should have given a list of those accidents which were due to the *presence* of the electric telegraph—amongst which they enumerate the celebrated Clayton Tunnel accident—and thus enable such disputants to show that the use of the telegraph is as broad as it is long, that while, in some instances, it might have prevented accidents, in other cases it produced them. The Clayton Tunnel accident would, in all probability, never have occurred if there had been no telegraph at that particular spot, but this is no argument against the use of a telegraph, because, in the first place, the accident was not due to the telegraph itself, but to the incomplete and inefficient regulations adopted in working it, and in the second place, while this single accident may be attributed to its presence, the hundreds of instances where accidents have been avoided are unheard of and unknown. One accident, involving the death of a passenger, produces intense sensation. The strictest enquiry is made into every detail. The telegraph, the staff, the rolling stock, the permanent way, in their turn, are severely criticised and censured. But the thousand and thousand hairbreadth escapes that passengers meet with, flow silently by, unheeded and unknown.

Many instances can be cited of the accidents saved by the use of the telegraph. Captain Tyler, in his report of the Clayton Tunnel accident, says:—

"On the Great Northern Railway the leading axle of the engine gave way, as the Scotch express train was entering the Tottenham Tunnel on its way to London, on the 27th July, 1860, while the train was traversing at a speed of perhaps 60 miles an hour. The engine swerved first to the right, to the down line of rails, and then after throwing off its left leading wheel, back again to the up line, on which it had been travelling; and it pulled up, in four hundred yards or so, with its train across both lines of rails. None of the passengers were hurt, and no one suffered but the fireman, whose thumb and finger were crushed between the hand-rail of the engine and the side of the tunnel, as he held on to the former; and it was to the circumstance that the engine thus grazed, and received support from the wall of the tunnel, that the fortunate escape of the passengers was, under Providence, due. But it was in the neighbourhood of this tunnel, that the two Scotch express trains, when they were in time, usually passed each other, the one being due to reach King's Cross at 9.30 p.m., the other to leave it at 9.50 p.m. Happily, the down train was somewhat delayed in starting, by the number of people who presented themselves to travel by it, and the tunnel was comprised in a section of line worked by telegraph. The signalman south of the tunnel received notice from the signalman north of the tunnel of the up train having passed him, and he was made aware of its having entered the tunnel shortly afterwards by hearing a bell ring outside of his hut, connected with a signal north of the tunnel, similar to that at the south end of the Clayton Tunnel, to which I have had occasion to refer. He observed that it was longer than usual in coming to him, and heard a good deal of whistling from the engine. He found that his telegraph would not work to the northward, and he received notice of the approach of the down train. He, therefore, took upon himself the responsibility of keeping up his signals against that train, under the apprehension that there might be something wrong in the tunnel and he thus prevented what might have been a most serious accident, as may be imagined, when I add, eight hours were afterwards occupied in clearing the down line before the train from the north could proceed on its journey."

Here is indisputable evidence of the value of a well-regulated telegraph. On the other hand, Captain Tyler, in the same report, says:—

"On the Great Northern Railway, on the 14th December 1853, three trains were passing through the Stoke Tunnel, half a mile long, between Corby and Great Ponton. The gradient was a descending one of 1 in 180, and the trains left Corby, which is eight miles to the South of Grantham, at 12.30, 12.35, and 12.45. respectively. The driver of the second of these trains slackened speed very properly, in order to avoid collision with the first; but in endeavouring to prevent one accident he occasioned another, for the third train caught up to the second train, and came into collision with it, when it proceeded about two-thirds through the tunnel, and the guard of the second, a coal train, was seriously injured.

"In my report of the 3rd January 1854, upon that accident, I was led to state prematurely that I was happy to learn that the tunnel was about to be worked by telegraph, no train being permitted to enter at one end of it until the preceeding train had passed out at the other end. This was not adopted sufficiently soon for the exigencies of the case; for within three months afterwards another collision occurred under precisely similar circumstances, on the 7th March, 1854. Three other trains left Corby for Grantham at 9.36, 9.45, and 10 a.m. The driver of the second train was proceeding cautiously through the tunnel, at a speed of about 14 miles an hour, that he might not run against the first train, and he also was caught up by the third train.

"After the second collision the tunnel was supplied with a telegraph."

I am, however, by no means an advocate for the general and

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indiscriminate adoption of the electric telegraph as a primary power into the working of railway systems. It is only in exceptional cases that its use is recommended. The most perfect telegraph is liable to occasional accident and interruption. It is, at the best, like most mechanical arrangements, an uncertain agent. Implicit reliance cannot always be placed upon its working. Its chief value lies in its secondary or auxiliary character. In this capacity it is an invaluable agent in the hands of a traffic manager. No railway should be without it. Upon single lines it is imperative. A single line with a telegraph is safer than a double line without one. It hastens the transaction of business, instils order and regularity in the running of trains, and produces punctuality, which is the greatest element of safety in the working of a railway.

It fortunately happens that accidents which affect trains very rarely injure the telegraph, and being chiefly required in such moments of emergency, it is, therefore, generally available. It should, for this reason, always be maintained in a state of efficiency. But accidents are, fortunately, few and far between, and a well regulated telegraph staff is frequently allowed to fall into irregularity through desuetude. Railway directors, after a serious accident, are liberal enough in their allowances for telegraphs, and other elements of safety; but long freedom from accident reduces their vigilance, and allows economy to become supreme. The staff is reduced, instruments are left unprovided for, and the system again becomes loose and irregular. Every instrument should have its proper attendant, boy, or clerk. An instrument at a station is perfectly useless without having some one to work it. A telegraph instrument without an experienced operator is as unserviceable as an engine without a driver. It is frequently left in the hands of persons incapable of using it; and it is no uncommon thing to find it placed under the charge of those who, though capable of working it, are—from a superabundance of other employment—unable to afford it that strict attention so necessary to make it a valuable and reliable agent.

The maintenance of an efficient telegraph system is, undoubtedly, costly. Its debits are only too visible—its credits are unknown. But how trifling is its cost when compared with that of a single accident! Captain Huish said (1852):—"If only one collision of a passenger train, with its sickening accompaniments of suffering, to say nothing of its heavy expense, were prevented by a free use of the Telegraph, the immunity would be cheaply attained, and the cost of the improvement be amply compensated." Its erection is cheaper than that of the fencing of the line. It can be worked either by boys or girls at a small weekly salary.

But to be maintained in constant efficiency it must receive the greatest personal supervison. The working of the circuits must be under constant control, or it is liable to be abused. Unremitting attention must be ensured. All elements of irregularity must be eliminated, and a careful check maintained over everything that passes through the wires.

A telegraph so maintained is a priceless power in the hands of a railway company. But how many companies are there who maintain such a system? I fear the number is small. Those who have it scarcely appreciate it, and those who appreciate it can scarcely induce their Boards to incur the expenditure necessary to maintain it in such efficiency.

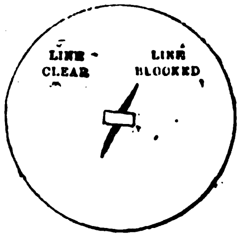
There are, however, exceptional cases where the employment of the telegraph, as a primary power to regulate the traffic, is imperative, amongst which may be enumerated—very crowded lines, like the London end of the London and North Western Line, the North London, &c.—single lines—junctions, which are always the greatest points of danger—heavy inclines—drawbridges—long tunnels, &c. In such places a well constructed and properly organised telegraph is essential to the welfare and safety of the line.

In referring to the auxiliary, or speaking telegraph, I have alluded to the needle system, the most perfect and complete for railway purposes in the world, and which, being universally employed for such purposes in England, requires no comment here. But for tunnels, &c., various systems have been adopted, a few of which I will now examine and describe.

Mr. Cooke, the original introducer of the Electric Telegraph into practical working, was also the first to point out the advantages of the use of the telegraph in railway working. He published a very interesting pamphlet in 1841, called "Telegraphic Railways," in which he suggested the principle of working which has been more or less followed in every system that has subsequently been introduced. He conceived a line of railway divided into certain spaces, each of which was governed by its own telegraph, and into which no second train was to be allowed to enter until the first train had been signalled clear of it. Thus trains, in place of being maintained at a certain presumed safe distance apart by intervals of time, would be kept secure by being divided by an interval of space, a far more satisfactory principle than that so universally adopted at present. Where fast expresses and slow goods' trains are travelling over the same line, now through a thick fog, now up a wet incline, it is almost impossible to maintain that rigid interval of time which is essential to prevent collision and obviate accident; but when two trains, however rapidly or slowly they may be running, are invariably kept apart by an interval of 2, 3, or 4 miles, such prolific sources of accidents are rendered impossible. This Mr. Cooke essayed to obtain by what is termed the "block" system.

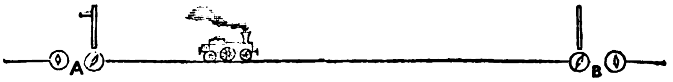
The line being divided into spaces, and each space having its own telegraph, each instrument should declare upon its face whether there was a train upon that length or not. The needle instrument which he employed has two signals,

Fig. 1.



the one to the left signifying "line clear," and the one to the right "train on line." Whenever a train entered the length

Fig. 2



A B, the man at A would signal "train on line," which would be acknowledged by B and maintained or "blocked over" until the train arrived at B, when B would signal "line clear." The man at A would keep his danger signal on until "line clear" was signalled, and no second train would be admitted until the first was out of that length. The out-door signals at A would, therefore, be a representation of the instrument at B, and the man at that station would have a complete control over the length A B. The signals at A would, in fact, be simply distant signals, worked by the man at B, and this is the correct principle of all telegraphic railway signals. It is impossible by mechanical means to work distant signals much beyond 1000 yards, but by the use of the telegraph this distance can be increased *ad infinitum*. The distant station becomes a distant signal, not worked mechanically direct, but subsidiarily, by the use of the Telegraph. It is evident that whether the telegraph be general, and the line divided into spaces, or whether it be local, and only

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applicable to a tunnel, or an incline, the principle is the same. It is the basis upon which all railway telegraphs are constructed, and the different systems employed upon different lines are simply mechanical improvements, or "colourable infringements," of Mr. Cooke's original idea.

(To be continued.)

THE SULPHATE OF LEAD BATTERY OF M. BECQUEREL.

A NEW form of battery, contrived by M. Edmond Becquerel, in which the sulphate of copper of the Daniell couple is replaced by the sulphate of lead, was recently submitted to experimental trial during several months in the central telegraph station at Paris. It was found that the electro-motive force of the new couple is insufficient to allow of its advantageous employment in telegraphy. It may, however, be useful to reproduce the inventor's description of this battery, given to the Academy of Sciences at their sitting of the 2nd of April, 1860.

"The sulphate of lead has the property, when formed into a paste, with a saturated solution of chloride of sodium (common salt), of becoming compact and hard; other chlorides occasion a similar effect. It is known that this property of hardening like plaster belongs to several bodies when impregnated with certain solutions. The sulphate paste may therefore be formed into cylinders, within which may be placed a rod of copper, of lead, of tinned iron, or even of gas carbon. These cylinders, after being dried, are permeable by the conducting fluid in which they may be immersed, and, with a plate of zinc and the fluid, constitute a "constant couple." Or, plates may be cast of this material; and, by placing one of these plates upon a plate of copper, lead, or tinned iron at the bottom of a suitable vessel, supporting a plate of zinc above the preceding, and filling the vessel with a solution of chloride of sodium, or acidulated water, a single fluid constant couple, without porous vessel, may equally be constructed. The cylindrical form, however, appears to me in most cases preferable, as well as the use of a diaphragm of cloth or porcelain, of a diameter somewhat larger than that of the cylinders.

"All samples of sulphate of lead do not behave in the same manner, probably by reason of their impurities. Some become very hard, whilst others do not obtain sufficient solidity, and soon become disintegrated in the interior of the couple. Without having ascertained the necessary conditions for avoiding, in certain cases, this inconvenience, I have observed that a mixture of 100 *grammes* of sulphate of lead, which has been dried and pulverized, with 20 or 30 *grammes* of chloride of sodium, and 50 *centimetres cubes* of a saturated solution of chloride of sodium, gives good results; the addition of 20 to 25 *grammes* of oxide of lead (massicot or minium), increases the hardness of the mass. There is, moreover, a means which allows of the employment of the various samples of sulphate of lead, and which may be preferred to any other; the coatings of the sulphate paste may be covered exteriorly with a slight coating of plaster, or the plaster may simply be run round the cylinder. The cylinder covered with plaster, when placed in the exciting fluid and surrounded by a hollow cylinder of zinc, constitutes a couple; by this means the breaking-up of the sulphate is avoided, and moreover there is no need of a diaphragm, this being replaced by the plaster which prevents the contact of the lead, which becomes reduced, and the zinc. This method of coating the solid sulphate of lead is also applicable to other compositions. I propose to investigate afresh the precautions to be taken in order to obtain, under the most favourable conditions, a compact and permeable mass.

"We may form a couple with a cylinder or plate of sulphate of lead prepared in the above manner, and a strip of zinc, amalgamated or unamalgamated, using either salt water or water slightly acidulated with sulphuric acid; when the latter is employed the electro-motive force is somewhat less than with the solution of chloride of sodium, but the solvent action of the latter upon the sulphate of lead, causes the zinc to become covered with reduced lead, which must occasionally be removed. With the acid mixture this inconvenience does not take place.

"The electro-motive power (tension) of the new couple, compared with that of a couple of amalgamated zinc, platinum, water acidulated to 1-10th, and nitric acid, is as follows:—

Couple with nitric acid	... ...	100
Couple with sulphate of copper (Daniell's) between...		58 and 59
Couples with sulphate of lead in compact permeable masses, and amalgamated zinc.	With a solution of chloride of sodium between	28 and 30
	With water acidulated with sulphuric acid	27

"During the first few moments of the action of the couples, the electro-motive force depends upon the nature of the conductor in contact with the sulphate; but as soon as a portion of metallic lead becomes reduced upon the latter, the force obtains a constant value. It answers every purpose, therefore, to employ a rod of lead for the negative element.

"In the action of the battery, the sulphate of lead is reduced to the metallic state, and the sulphuric acid which enters into its composition forms, with the zinc, a sulphate of this metal. It is easy, by means of the chemical equivalents, to ascertain the relative weights of the two electrodes in each couple necessary to maintain their constancy during the period the voltaic action lasts. For 100 *grammes* of zinc, 470 *grammes* of sulphate of lead are required, that is to say, nearly five times more sulphate than there is zinc."

These solid masses, permeable to fluids, and employed for the negative electrode, obviate polarization, and perform the same function as the peroxides of manganese and lead, nitric acid, and metallic salts, which become reduced; but their resistance to conductivity, which varies as the reduction of the sulphate proceeds, is an obstacle to the employment of these single fluid couples for the same purposes as the nitric acid arrangements. I have little doubt, however, that where batteries of great resistance and long duration of action are required, the couple described may be employed with advantage.—*Annales Télégraphiques.*

ON SOME NEW PHENOMENA OF RESIDUARY CHARGE AND THE LAW OF EXPLODING DISTANCE OF ELECTRICAL ACCUMULATION ON COATED GLASS.

BY SIR W. SNOW HARRIS, F.R.S.

A MAIN object of this paper is to prove that residuary charge in the Leyden jar, subsequent to explosive discharge through an external interrupted circuit, as in the case of discharge by a Lane's electrometer, is not the result of a spreading of the charge upon the uncoated part of the glass, or of penetration within its substance, but arises from an undischarged portion of the accumulation left as it were behind, and still existing in precisely the same way and under the same conditions as the original charge.

The author introduces his subject with sundry observations on Lane's discharging electrometer, and the law of explosive discharge, and adverts to the fact recorded by Nicholson in the Royal Society's Transactions for 1789, that "although in moderate charges the exploding distance appears exactly, or very nearly, proportionate to the charge itself, yet for high intensity, the distance to which the charge is carried exceeds that proportion:" this the author finds to be the case generally, and quotes an experimental example showing the amount of deviation from Lane's law in that particular instance. He further shows, that in order to obtain explosive discharges at the increased distances, agreeing with the calculated number of measures, the distances must be slightly increased by certain small quantities.

The probable sources of these differences are now adverted to, and the common objections to Lane's discharging electrometer considered. A new and improved form of this instrument is figured and described. One of its principal advantages is a means of changing the exploding points of the discharging balls, which are moveable on axial centres, so as to bring a new point of the circumference into play, should abrasion or any other defect arise in the existing exploding point. The author endeavours to show that the apparent irregularities so frequently observed in the striking distance of a charged electrical jar, do not arise from any defect in the quantity measure, or in the exploding electrometer, when properly constructed, but are altogether dependent on some peculiar conditions of electrical accumulation on coated glass.

One remarkable peculiarity of the electrical jar, is a disposition to retain a portion of the charge, notwithstanding explosive discharge has occurred through a discharging circuit; we do not discharge the whole accumulation; a portion is, as it were, left behind. The fact itself is undisputed, but the cause or theoretical explanation does not appear to have been very clearly comprehended.

The author here introduces some interesting quotations from certain unpublished manuscripts of Mr. Cavendish, who investigated, so long since as the years 1771 and 1772, what he terms the "charges of plate glass and other electrical substances coated in the manner of Leyden phials." Mr. Cavendish found his experimental inquiries greatly embarrassed by the "spreading of the electricity" on the glass; it is, he says, faster on some kinds of glass than on others; besides the slow and gradual spreading, he observed an instantaneous spreading, visible in the dark, and extending to about ·07 of an inch beyond the edge of the coating upon glass ·2 of an inch thick, and

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about 0·9 upon glass $\frac{1}{7}$th of an inch thick. Another source of inconvenience, observes Mr. Cavendish, arises from a certain amount of penetration of the charge into the substance of the glass itself, equal to about $\frac{7}{10}$ths of its thickness; the space, he says, within which the charge cannot penetrate is not above $\frac{1}{8}$th of the thickness, from which he concludes that the charge of a coated electric will be different in cases in which this penetration of the charge into the substance of the glass varies, and infers that different electrics are susceptible of different degrees of charge. He examined plates of glass of various kinds, as also of gum-lac, rosin, bees-wax, &c., and found the capacity of these substances for electrical charge different—phenomena recently explained by Faraday's fine discovery of Specific Inductive Capacity.

This last celebrated philosopher also recognises the penetration or infiltration of electrical charge within the substance of coated and charged electrics, and attributes it to a certain amount of conducting power in the electrical substance. All substances, he infers, are conductors of electricity in a greater or less degree, and thus admit of infiltration of charge through their substance. In the case of charged electrics, the infiltrated electricity subsequently returns upon its path, and hence residuary charge.

The author has no disposition to question the experimental results arrived at by either of these eminent men, but is of opinion that they apply to a different case of electrical force than that of secondary and immediate discharge, supervening upon a primary discharge of an electrical jar through an external explosive circuit, which he thinks can neither be referred to any previous spreading of the charge upon the glass, or to any penetration of it into its substance, or to return action as described by Faraday. He has found that of 100 measures of accumulated charge on a jar with imperfect conducting coatings, no less than 75 measures, or three-fourths nearly of the whole accumulation, has been left behind after explosive discharge. In a jar coated with water full 14 measures out of 100, or about one-seventh, was left undischarged. He thinks it difficult to reconcile such an amount of residuary charge as this, with any spreading of the electricity on the glass, or any possible amount of penetration into its substance.

Although the deductions of Cavendish and Faraday may not be found to apply as solutions of the interesting problem of residuary charge, they still find their application in other cases, as in the case of the facts noticed by Nicholson already detailed. The intensity of explosive discharge may apparently become increased by a penetration of the exploding electricity into the air separating the balls of the discharging electrometer, in which case the measured distances of discharge, according to Cavendish, would, for given measured quantities of electricity, continually decrease, and discharge at the measured distances between the exploding balls would appear to happen prematurely. It is now shown by reference to a table of experimental results, that at distances 1, 2, 3, 4, taken in tenths of an inch, with quantities of measured charge also as 1, 2, 3, 4, the actual distances of explosion are nearly as ·1, ·214, ·325, ·445. The author hence infers that, supposing the penetration of the first measures very small and not of much value, the penetration of the succeeding measures may be taken as ·014, ·025, ·045, that is ·007, ·0125, ·0225 upon each of the opposed exploding points, taking the surfaces of the exploding balls as curvilinear coatings to the intervening air.

If any considerable spreading of the charge upon the uncoated glass should arise, that, as remarked by Cavendish, would be equivalent to an increase of the coating, and hence the tension due to a given quantity of charge would be less. The effect would be greater on the first measured quantity than on succeeding quantities; hence for explosion at a first distance, an additional two or three measures might be required, which, as the spread upon the glass became satisfied, might not be requisite in the same proportion upon succeeding measured distances, in which case discharge would ensue with a less number of measures than calculation determines according to Lane's law, making it appear as if, according to Nicholson, "the intensity ran before the quantity."

Both Franklin and Nicholson have taken a sound practical and theoretical view of electrical accumulation on coated glass, which the author conceives to depend on a play of opposite electrical forces, either directly through the glass intermediate between the coatings, or through the medium of an external circuit, or both. He considers the terms "free" and "compensated," or "latent" electricity, perfectly admissible when correctly applied and limited by sound definition. All the accumulated charge, up to the exploding point, is evidently not sensible to the electrometer, and he thinks it convenient to distinguish between that portion of the charge of which the electrometer directly says nothing, and that portion to which its indications are more immediately referable, more especially as these two, or conjugate portions, have important relations to each other. Thus a double measured charge has twice the amount of free charge; and the free charge, as estimated by attractive force, is as the square of the accumulation. When the free charge explodes, the whole accumulation, or nearly all, goes with it, at least in common cases of metallic coated glass, and according to Nicholson carries it through distances proportionate to the charge itself: the terms "free" and "latent" electricity, or, as the French have it, "*electricité dissimulée*," may not be exact or admissible, if meant to imply a difference in kind or mode of action of electrical force, but they are by no means objectionable when denoting different amounts of the same force in this or that direction.

(*To be continued.*)

REPORT OF THE ELECTRIC AND INTERNATIONAL TELEGRAPH COMPANY FOR THE HALF-YEAR ENDING 30TH JUNE, 1862.

IT will be remembered that, in the last half-year's report, the directors announced their intention of making a general reduction of tariff to all places of considerable traffic within an area of 300 miles: this reduction took effect on the 1st of February, and, although, as anticipated, the diminished charge has not yet been compensated by increased business, the sacrifice has been less than could reasonably have been expected. In addition to this, the loss on the long circuits to Liverpool, Manchester, &c., from the shilling tariff introduced by the United Kingdom Telegraph Company, has continued unabated during the half-year, and the ordinary revenue has thereby been diminished to the extent of many thousand pounds.

On the other hand, there has been a steady improvement at many of the numerous stations of the company unaffected by the competition. The opening of 167 additional stations (principally on railways), for commercial purposes, has further contributed to swell the receipts, and there has been a satisfactory increase in the Company's foreign business. Your directors have entered into extended arrangements, of a favourable character, with Continental Governments, which, by opening a wider area of operation, have led to a large expansion of traffic, which will be further developed when the new cable, now completed, and about to be submerged, is brought into use.

The combination of the latter circumstance has, happily, neutralized the loss caused by the reductions alluded to above; and the directors have much satisfaction in stating that the gross revenue of the half-year amounts to £102,367, against £102,519 in the corresponding period of 1861. It is gratifying to add that the large addition of work which the Company has undertaken has been performed with increasing accuracy, the percentage of errors, minute as it was, having been considerably reduced.

The working expenses present few marked features. The mantenance charge is somewhat less, but may, probably, be proportionably increased during the current half-year; and the absence of casualty to any of the company's cables since the last meeting has largely diminished the cost of their mantenance. One considerable item, viz., that for law and parliamentary expenses, appears in the present balance-sheet. The board have considered it right to charge the whole of the expenses of the late contest against the revenue of the half-year, and no debt on this account will remain on the Company's books.

Deducting from the gross revenue of £102,367 the working charges and interest amounting to £71,131, which includes the exceptional item of £6,056 alluded to, there is a clear profit of £31,236 on the operations of the six months, and the directors are, consequently, enabled to maintain the usual dividend of £3 10s. per cent. for the half year, which will absorb £29,816, leaving a balance of £1,420 to be added to the account for the renewal of the submarine cables.

The Renewal Fund amounted on the 7th day of March, 1862, to £51,061, from which an advance of £25,000 having been made to Messrs. Glass, Elliott, and Co., on the cable being completed, there remains a balance, which the present appropriation will increase to £27,481.

The new communication through the Company's system from London to Cork and Queenstown, as approved by the proprietors at the last meeting, is nearly completed. The cable of the London and Queenstown Direct Telegraph Company from Abermawr Bay, in the county of Pembroke, to Greenore Point, in Wexford, was laid in March last, and works perfectly. It is probably known to the proprietors that some time ago, a South of Ireland Telegraph Company was started to effect the same objects which this company had in view, and commenced laying its wires. It appears, however, that the parties became satisfied of the prudence of not proceeding with their intention, and tendered their unfinished works to your directors. Finding

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that they could be advantageously used in completing this Company's connection with the important district sought to be accommodated, the board accepted the offer and purchased them on satisfactory terms. The Company is consequently relieved from the loss which would have arisen from a division of the traffic with America, and the active ports on the south of Ireland.

Towards paying for this and other extensions the Board will immediately call up the last instalment on the new shares.

Your Directors considered it their duty to oppose the Bill of the United Kingdom Company. In this they were unsuccessful, but the result has justified their proceedings. The principles on which the United Kingdom Company appealed to the public—*superiority of system—uniformity of charge*—and a *maximum tariff of a shilling*—have successively proved admitted failures: all pretence of the first was soon abandoned, their new patents discarded, and the ordinary instruments employed. Uniformity of charge was given up by the promoters in the House of Lords as untenable, and a scale of charge according to distance inserted in the Bill; and, as regards the shilling tariff on long circuits, it appears from the evidence of the Secretary of the United Kingdom Company himself, that after many months' experience on 415 miles of line, embracing the most productive telegraphic circuits in the kingdom (London, Oxford, Leamington, Birmingham, Wolverhampton, Liverpool and Manchester being included), the total receipts of the United Kingdom Company fell short of their actual working expenses to the extent of *six thousand a year*. This corroborates the statements made to you from time to time, and further extension on similar principles must enhance the loss to them as well as to yourselves.

Your directors regret the sacrifice, but they derive satisfaction from the reflection that if it has retarded, it has not prevented, the well-considered and prudent reductions which have periodically been made by the Electric Telegraph Company, and which, when effected on sound principles, are alike beneficial to the public and conductive to the Company's interest.

Further reductions are now under consideration, and the proprietors may rest satisfied that, although it is not improbable the new company may, at a ruinous loss to themselves, interfere further with your traffic, it is out of their power materially and permanently to affect your position, based as it is on the possession of 841 telegraphic stations in Great Britain and Ireland, in constant communication with 3,500 telegraphic stations on the Continent of Europe.

29th July, 1862. Robert Grimston, *Chairman*.

ELECTRICIAN'S REPORT.

Gentlemen,—Your lines and circuits are, generally speaking, working satisfactorily, and where re-insulations are needed they will be carried out before the wet season sets in.

Your submarine cables are all in the same condition as when I last reported, and continue in good working order.

The first half of the new cable to Holland has been successfully submerged, and the other half will be laid, wind and weather permitting, in about a week or ten days. As soon as this cable is complete it will be put into operation.

Since my last report, wires have been erected and communication opened between Cardiff, Rochès Point, and Waterford. The wires between London and Cardiff are in a forward state, and in about three week's time direct communication will be established thereby between London, Cork, Queenstown, and other stations in the south of Ireland.

The following additional works have been completed or are in progress:

The erection of the telegraph on the Stratford-on-Avon Branch of the West Midland Railway. Between Halstead and Yeldham on the Colne Valley Railway. On the Nidd Valley and other Branches of the North Eastern Railway. On the Cockermouth and Workington Railway, and on some Branches of the Midland Railway. The erection of additional wires between London and Lowestoft, and between Zandvoort and Amsterdam to meet your new cable; on the London and North Western, Great Northern, and Birkenhead Railways. Your wires have also been extended into the Stock Exchange, Manchester, and into the Building of the International Exhibition of 1862.

Since June, 1861, your lines have increased nearly 600 miles, or 1-11th of your whole system; the length of wire nearly 1,700 miles, or nearly 1-20th of your present system; and the number of instruments by 272, or 1-13th of the total number. By far the greatest part of this increase has been made during the half year just expired.

Your present mileage is as follows:—

Miles of line	7,222
Miles of wire	34,255
Number of instruments	3,719

Cromwell F. Varley, *Electrician*.

Balance Sheet.

	£	s.	d.	£	s.	d.
Consolidated Stock ...	719,900	0	0			
New Shares (7,199) £20 paid	143,980	0	0			
Calls paid in advance ...	17,790	0	0			
				881,670	0	0
Debenture Debt				52,750	0	0
Fire Insurance Fund ...				335	7	3
Balances due to Sundry Creditors				44,881	15	6
Undivided profit 31st December, 1861, less carried to Trust Account				6,362	0	2
Trust Account:—						
Balance 31st Dec., 1861	41,743	18	5			
Half Year's Interest ...	516	3	0			
Surplus 31st Dec., 1861	8,801	5	2			
	£51,061	6	7			
Advance on account of New Cable	25,000	0	0			
				26,061	6	7
Balance of Revenue Account as under				31,235	11	5
				£1,043,296	0	11

	£	s.	d.
Total cost of the construction of the Electric and International Telegraph	866,021	19	7
Channel Islands Telegraph	4,200	0	0
New Central Station and Camden Stores	23,534	16	8
Value of House Property in London	10,391	14	7
Balances due from sundry Debtors	61,470	1	1
Calls in arrear	330	0	0
Value of Stores	38,540	8	1
Securities in hand	2,785	13	6
Trust Account agreed to at the Half-Yearly Meeting, 31st July, 1858	26,061	6	7
Balance at the Bankers ...	9,960	0	10
	£1,043,296	0	11

Revenue Account.

	£	s.	d.	£	s.	d.	£	s.	d.
Receipts for Messages, Subscriptions, Intelligence, Maintenance Contracts, Interest, and Transfer Fees...				105,873	16	4			
Less Porterage paid out				3,506	16	4			
							102,367	0	0
Salaries and Wages				31,090	0	5			
Station Expenses				3,069	11	2			
Rent, Taxes, Gas, and Insurance				5,486	11	1			
Books, Stationary, and Printing				3,066	10	4			
Postage				191	1	9			
Newspapers, Lists, and Reports				866	11	1			
Law and Parliamentary Charges				6,056	11	2			
Continental Agency				592	3	7			
Direction and Audit				1,200	0	0			
Maintenance, Labour	£9,116	16	1						
" Materials	7,676	14	5						
				16,793	10	6			
Contribution to Sickness Fund				85	3	0			
Expenses of *Monarch* Steam Ship				828	1	8			
				69,325	15	9			
Interest on Debenture Debt ...	£1,233	11	5						
Interest on Loans	49	16	4						
Interest on Calls paid in advance	522	5	1						
				1,805	12	10			
							71,131	8	7
							£31,235	11	5

Examined and found correct,

July 29th, 1862. JAS. ROLLS, ALEX. SIM, } *Auditors*.

General Balance.

	£	s.	d.
Dividend on £719,900 Consolidated Stock at £3 10s. per cent. for the half-year ending 30th June, 1862	25,196	10	0
Dividend on 7,199 New Shares, at 12s. 10d. per share (£3 10s. per cent.) for the half-year ending 30th June, 1862	4,619	7	2
Undivided profits to Dec. 31st, 1861 ...£6,362 0 2			
Balance after payment of dividend... £1,419 14 3			
	7,781	14	5
	£37,597	11	7

	£	s.	d.	£	s.	d.
Balance after payment of dividend, 31st Dec., 1861... ...	15,163	5	4			
Carried to trust account ...	8,801	5	2			
				6,362	0	2
Balance of revenue account, 30th June, 1862				31,235	11	5
				£37,597	11	7

July 22nd, 1861.

Investment of Trust Fund.

	£	s.	d.
£10,000, Three per Cent. Reduced, cost	9,166	15	0
£5,000, Three per Cent. Consols, cost...	4,601	7	6
Cash at bankers on deposit ...	11,600	0	0
Balance in cash...	693	4	1
	£26,061	6	7

ROBERT GRIMSTON, *Chairman*.
J. S. FOURDRINIER, *Secretary*.

N.B.—It is proposed to pay the dividend on the 15th August.

N.B.—The thirty-third half-yearly ordinary meeting of the proprietors of this company is appointed to be held at the Company's General Offices, Telegraph Street, Moorgate Street, London, on Tuesday, the 5th August, 1862, at two o'clock precisely, pursuant to the Act of Incorporation.

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PRICES CURRENT OF INSULATING MATERIALS.

Gutta Percha.

Fine	2s. 6d.	per lb.
Genuine mixed	1s. 11d. to 2s.	„
Ordinary reboiled	0s. 9d. to 0s. 10d.	„

India Rubber.

Para, fine	1s. 10d. to 1s. 11d.	per lb.
Negro Head	0s. 11d. to 1s. 1d.	„
Java	1s. 5d.	„

August 7, 1862.

Wm. Kirkmann,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	50 to 55	——
20	Do. B 7 per cent. till 1862 .	all	19 to 21	——
20	Do. C. „ „	all	——	——
10	London & S. of Ireland Direct.	2	— —	——
Stock	Electric Telegraph . .	100	101 to 105	——
5	London District Telegraph .	4¾	3¾ to 3¼ dis.	——
10	Mediterranean Extension Tel.	all	3½ to 4½	——
20	Red Sea and India Telegraph	all	——	——
1	Submarine Telegraph, scrip.	all	⅜ to ⅝	——
1	Do. registered . . .	all	⅜ to ⅝	——
10	Do. „ . . .	all	4 to 6	——
2	Telegraph to India . .	1	⅝ to ⅜ dis.	——
5	United Kingdom Telegraph .	8	½ to ¼ dis.	——

Recent Patents.

58. H. Cook, Manchester, "*Transmitting despatches and small articles by the agency of electricity.* A communication. Dated 8th January. 1862.

The patentee claims the application of the tractive power of electric coils to cause an armature of iron, constructed in the form of a hollow vessel, casing, or carriage (made to contain articles of various kinds), to pass along a continuous line of rails placed within and extending throughout a series of tubular electric coils, as herein set forth.

59 C. W. Siemens, Great George-street, Westminister, "*Insulating and protecting telegraph conducting wires.*" Partly a communication. Dated 9th January, 1862.

One part of this invention consists in certain improvements in the mode of insulating and protecting electric telegraph conductors, or in constructing what are commonly known as electric telegraph cables, and in the apparatus employed for that purpose. The patentee forms the conductor of the electric currents, either of a solid metal wire, or of a strand of two or more wires; or he sometimes first forms a strand of seven equal-sized wires, and then winds into the six helical recesses formed between these wires, six other conducting wires of a smaller diameter, so as to cause the form of the complete conductor to approximate to that of a cylinder, which form would present the least surface for induction for a given sectional area. He causes the conductor to pass through a vessel containing either a compound of gutta percha, resin, and Stockholm tar (well known under the name of "Chatterton's compound,") or any other suitable insulating substance or compound in a heated or semi-fluid state, so that the wires or strand of wires become coated with the same. The wire or strand of wires passes into and out of the vessel through holes or dies formed in the sides of the same. He sometimes heats the wire or strand of wires before passing into the vessel, and in some cases he applies the mixture or substance contained in the vessel under pressure to insure its more perfect adhesion to the conducting wire or wires. On emerging from the above named vessel, the coated conductor is passed through a bath of cold or iced water, or any other suitable medium maintained at a low temperature, and is then passed round a series of rollers or reels so as to harden the coating, and prevent its sticking when coiled upon a drum. He then covers the conductor with one or more coatings of india rubber, or any of its compounds, as described in the specification of former letters patent granted to him, and bearing date the 3rd day of November, 1859 (No. 2503), and afterwards with one or more coatings of gutta percha, with or without intermediate layers of Chatterton's mixture, or other suitable compound. In making points in the before-mentioned india rubber covering of the conductor he first points the wire or wires in any suitable known manner, and then overlaps the uncovered of part the same with india rubber strips to about the thickness of the coating of the wire or wires. He then completes the formation of the joint in a specally constructed apparatus. The invention cannot be fully described without reference to the drawings.

Telegraphic News.

ELECTRIC AND INTERNATIONAL TELEGRAPH.

The half-yearly meeting of this Company was held on Tuesday last, at the offices, Telegraph street, the Hon. Mr. Grimston in the chair.

The report, an abstract of which has appeared in the *Times*, was taken as read.

The Chairman, in moving the adoption of the report, referred to the slight diminution in the receipts. The reason was that they had been compelled to carry messages to Manchester and other large towns at a rate which did not pay the working expenses. This was an ordeal the the Company was obliged to go through, the bublic believing that the more the tariff was reduced the greater would be the profit. The experiment was tried, not at the expense of the public but at that of the Company. The shilling rate for messages had been tried by three companies, and the Electric had carried them at a loss, and he was authorized to say that in the Magnetic Company it was the same. He then combatted the statement of Mr. Andrews that as a low tariff had been successful on the continent it would necessarily be successful in England. In many cases the continental lines where held by the Governments not for the purpose of profit, but for the purpose of trade. He contended that the 1s. tariff was impracticable. The policy of the Company since its commencement had been to make gradual and systematic reductions, and during the last half-year they had reduced the rates to a great many stations, and upon the general system where there had been no reduction, the increase in the messages had been so steady that it nearly covered the loss on the 1s. messages. The Company during the half-year had carried 132,000 more messages than in the corresponding period of 1861. There had been a reduction of 400*l*. during the half-year in the stationary account which was owing entirely to the abolition of the paper duty. Since the last meeting the Company had opened several stations in Ireland, with great success, and when the stations at Cork and Queenstown were opened it could not fail to result in a large increase of business.

The report was then adopted, the dividend declared, and a vote of thanks to the chairman closed the proceedings.

Mr. Robert Dodwell has been appointed Superintendent and Engineer to the Magnetic Telegraph Company's Midland District, the appointment to date from the 1st January, 1862.

The central police station at Hull has been connected by telegraph with the waterworks at Stoneferry. Henley's new dial instruments are at work on the line, which has been highly approved by Colonel Woodford, the Inspector of Police for the district. It is contemplated to extend the line to the reservoirs at Springhead.

Mr. Z. C. Pearson, the Mayor of Hull, has had a private line of telegraph extended from his residence to his offices in Hull. After mature consideration he has determined to use Henley's dial instruments, upon which we have had occasion lately to speak so favourably. The wire passes under the docks at Hull, through pipes laid in such a manner as not to interfere with the ships passing in and out by the main bridge.

The contractor's for Bonelli's line of telegraph, consisting of thirteen wires, between Manchester and Liverpool, expect to hand over the works to the company in the course of next week.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of The Electrician.

Sir,—An electrical conductor, giving a spark one inch in length, will attract light substances at a distance of four or more inches, whilst a thunder cloud giving a flash of sufficient intensity to rend a church steeple, will not move a feather at the same distance its spark will reach. Does the fact of "the force of electrical attraction diminishing as the squares of the distances" sufficiently explain the discrepancy?

A gold-leaf electrometer being so exceedingly sensitive to the feeblest electrical currents, is its slight disturbance during a thunderstorm sufficient to account for a cloud attracting a heavy column of water at one distance, whilst at a few yards beyond that distance it will *practically* attract nothing?

Do not the millions of points presented to a thundercloud by the vegetation on the surface of the earth, draw off much electricity silently? If so, this may partially explain the slight attraction to which I have referred, and may perhaps account for various electrical phenomena being more common at sea than on land.

I have again to thank you for your explanation, and wish to add, I have been much pleased with the prompt replies given to all my questions, since The Electrician first started, and have noticed that other enquirers appear to have the same reason to be satisfied.—Yours respectfully, X.

Haverfordwest, July 31, 1862.

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TUNNEL TELEGRAPHS.

To the Editor of The Electrician.

Sir,—A correspondent in your last number justly complains of the abrupt termination of the above subject. I regret very much that in consequence of the press of business at the time, I was prevented from continuing the correspondence, and now, before I trouble you again, it is my intention to first visit the International Exhibition (which I hope to do in the course of next month), where I shall minutely examine the various instruments in Class XIII.

I must confess that I gained much valuable information from your correspondents, and I am sure if a few more of our railway telegraph superintendents and inspectors would favour you with a little of their practical experience on the subject, it would be very interesting to your readers generally, and to none more so than to your humble servant,

Inquisitive.

Manchester, August, 5, 1862.

To the Editor of The Electrician.

Sir,—Will you kindly inform me on the following points:—I wish to make a magneto-electric machine similar to that on page 113 of your Journal. I have a large compound horse-shoe magnet, the poles of which are very close together and 4 inches in height, each pole being 1¾ inches in breadth; consequently, the currents of the same direction follow each other so close as to be merged into one, whilst those of the opposite direction are a long distance from each other; but I suppose this will not interfere with any experiments.

I beg to offer an improvement on the contact breaker shown by you (fig. 3, page 113). I place a spring on either side the axle, thus, in the present position of the charger, spring *s* would be pressing *b'*, and spring *s'* on *a*, thus doing away altogether with the two plates *a'* and *b*, and also equalizing the pressure on the axle. I have fitted this to my machine, and it answers well.

Please inform me the porportionate size of armature, coils, thickness, and length of wire for intensity purposes to be fitted to a magnet of above size, viz., 16½ inches long, 4 inches high, each pole 1¾ across, breadth of magnet at poles 3¾ inches, composed of 14 plates, and also the size of armature, coils, and wire for quantity arrangement. An answer will oblige, yours truly,

Archimedes.

Manchester, August 2, 1862.

P.S.—If you can inform me of any book giving full instructions I shall be glad. I have "Noad's Lectures on Electricity," but he does not give the necessary information for having one made.

Miscellanea.

The following poetical version of the discovery of the spark produced by magneto-electric induction appeared in *Blackwood's Magazine*. Our readers are aware that when the primary circuit of a magneto-electric coil is broken or completed, a spark occurs in the circuit of the secondary wire.

"Around the magnet, Faraday,
Is sure that Volta's lightnings play;
But how to draw them from the wire?
He took a lesson from the heart:
'Tis when we meet—'tis when we part,
Breaks forth the electric fire."

M.

Poisonous Pigments.—We can look with admiration upon the art of applying pigments to cloth when such innocent substances as ultramarine are employed for the purpose of producing the colours desired; but when we see those greens which are produced from arsenic and copper, our admiration of the art vanishes altogether. These substances are extremely poisonous—poisonous to the persons who wear them, and poisonous far more to the persons who make them for the wearer. Those poisonous colours that are applied by topical fixing, are merely put on by a sort of glue upon the surface of the cloth. They are stuck on, in fact, by cheese, and if, by any friction, a portion of them rubs off, they form a fine dust, which floats in the air and is readily breathed into the lungs. To give you some idea of the poisonous properties of this substance, I may mention that a lady in the extensive folds of a modern dress made of green tarleton wears as much arsenic as would poison a hundred and fifty stalwart men. In addition to this, the colour is often put on with much less firm substances than those I have described to you. I have been describing the genuine way of applying it, by means of lactarine and albumen, but in order to produce these green dresses very cheaply, this poisonous pigment is often put on only with starch, and it then rubs off with the greatest freedom. You have lately seen accounts of coroner's inquests held in this town upon poor flower-girls who have been poisoned by his colour in the making of green flowers. The amount used for that purpose is large. A lady's ordinary wreath of green flowers contains as much arsenic as would poison five men, so that the amount used of these poisonous materials is very great. It is a serious question, and I hope that you will see that I am not dwelling upon it too long. I am desirous to prevent persons using such poisonous materials. I may mention to you what Napier says in his "Manual of Dyeing." He says, that he has known workpeople become invalids for life by having to wind as many yards of arsenic sage yarn—that is to say, yarn dyed green with this poison—as gave them in wages only one shilling. We must not avoid a solemn truth for fear of a pun when we allege that this is not the art of *dyeing*, but of *death*. If purchasers will avoid these fatal pigments, manufacturers will soon abandon their preparation.—*Dr. Lyon Playfair.*

Siemens' New Electric Induction Coil.—"We are glad, through the kindness of Mr. Siemens, to be able to place before our readers a condensed account of this very remarkable apparatus, which created so much admiration at the conversazione of the Royal Society. The iron core consists of varnished straight iron wires, 37·4 in. long, and 0·05 in. diameter, arranged so as to form a cylinder 2·36 in. diameter. The primary coil is formed of two wires, laid side by side, of 0·1 in. diameter, and the resistance of each wire is equal to that of a column of mercury 30 metres long, and 1 square millimetre sectional area, measured at the freezing point of water. By means of a commutator, the two wires can be connected parallel or successive, as may be most suitable for the electromotive force applied. The primary coil is inclosed in a cylinder of ebonite, much thinner at the centre than at the ends, where the higher tension requires a greater thickness of insulating material. For the secondary coil, the space round the above ebonite cylinder is divided by thin circular discs of ebonite into 150 grooves, each of which is filled with wire 0·006 in. diameter, wound in the adjacent grooves in opposite directions, and all connected so as to form one continuous length. By having the secondary coil divided into many separate coils, the tension of the contiguous wires is considerably diminished; and, by winding the wire in the adjacent grooves in opposite directions, is obviated the necessity of guiding the wire from the end of one coil to the beginning of the next, which might be attended with danger, as the tension in the wire so guided near the insulating and separating partition between two coils would vary considerably from that in the layers by which it would have to pass. The total length of the wire in the secondary coil is 11,762 yards, or 6·68 statute miles, and the total weight of the same is 64 lb. The resistance of the wire equals 162,000 mercury units, and the number of windings amounts to 299,198. The condenser in this instrument is made of several discs of paper glued together and covered by tinfoil, the surface of the two tinfoil coatings measuring 16 square feet each. The elements used for the galvanic current in the primary coil are charcoal plates immersed in nitric acid, surrounded by zinc plates immersed in diluted sulphuric acid, the liquids being separated by porous cells. The mechanism for the make and break contact is put in motion by a couple of Daniell's elements, and contact is made by a platinum point dipping into a vessel containing mercury amalgam covered with rectified spirits of wine. The condenser is, in this apparatus, of very little importance, as far as regards the length of the spark from the secondary coil; but it is important to prevent the mercury in the vessel, where the make and break contact takes place, from being thrown about. When two elements were applied to this induction coil, the two wires of the primary coil being connected parallel, the spark from the secondary coil traversed a distance of 12 in., and 13½ in. when six elements were applied. Later in the evening, the spirals in the primary coils were connected as one continuous circuit, and the distance between the two points of contact of the secondary coil was increased to 19 in. The electricity was then seen escaping at many points of the coil by flashes of light flying in the air. The coil, however, was not tested to its full power, the batteries having been connected in a great hurry without due care, and some of them had been somewhat damaged during transport. When the coil was tried on a former occasion, the following results, it was stated, were obtained:—1, Bunsen's element gave sparks 8·4 in. long; 2 elements, 15·6; 3 ditto, 19·0; 4 ditto, 20·4; 5 ditto, 22·0; 6 ditto, 23·2. It is remarkable that this coil, which only contains *six* miles and a half of wire, gave, owing to its particular construction, at least the same effects as were obtained with a coil of the usual construction having *fifty* miles of wire for the secondary coil."—*Illustrated London News.*

Use of Chinese Characters in Telegraphy.—The Count d'Escayrac de Lauture has written an interesting pamphlet "On the Telegraphic Transmission of the Chinese Characters," in which he describes the system he has invented. The count remarks, that "by the aid of 1680 characters, or signals, easily assembled on a table of less than a foot square, the whole Chinese language may be written and transmitted; and he observes, that of all known languages the Chinese is the one of which telegraphic transmission is the easiest.—*London and China Telegraph*

To Correspondents.

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The Electrician.

Vol. II. No. 41.—August 15, 1862.

CONTENTS:

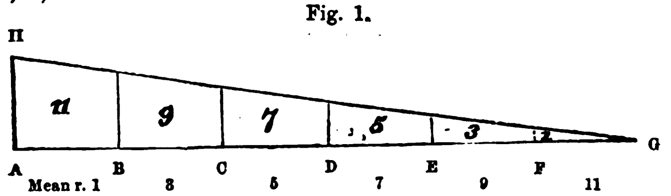
	Page		Page
On the Comparative Periods of Charge of Various Lengths of Submarine Cable	169	The Induction Coil	176
Some Considerations on the Principles of Electrical Conduction and Accumulation	169	Iron Covered Cables	176
On the Electrical Law of Distance	171	Electro-Metallurgy	177
On Railway Telegraphs	172	Prices Current of Insulating Materials	179
On Some New Phenomena, &c.	174	Telegraph Shares	179
		Telegraphic News	179
		Correspondence	179
		Miscellanea	180
		To Correspondents	180

ON THE COMPARATIVE PERIODS OF CHARGE OF VARIOUS LENGTHS OF SUBMARINE CABLE.

We cordially welcome the method suggested by Mr. Laming for arriving at the comparative periods of time occupied in the distribution of the static charge, in various lengths of wire under similar conditions for electrical accumulation; for if it have not already given results that accurately represent the facts for all the cases, it seems capable of doing so. The data probably admit of a closer approximation to the actual working conditions of the wires, and we are anxious that they should receive full consideration; for, in going through some further calculations, our correspondent has arrived at a conclusion that the true ratio must in all cases come out to be simply as the lengths inversely, a result which is in opposition to that we arrived at.

We have seen that the quantities of electricity accumulated in each section of a submarine, or other conductor, divided into any number of equal lengths, and connected with the battery at one extremity, and to earth at the other extremity, may be represented by the odd numbers, 1, 3, 5, &c.; the charge of the section led to earth being taken as unity. It will now be perceived that the *mean resistance to the passage of every unit of charge in each respective section* may be represented in any given case by the same numbers disposed in inverse order. Thus, in the following diagram, the units of charge in each section, commencing with A B, are expressed by the numbers 11, 9, 7, 5, 3, and 1; and the mean resistances to every unit of charge in each section from A B may be shown by the numbers 1, 3, 5, 7, 9, 11.

Fig. 1.

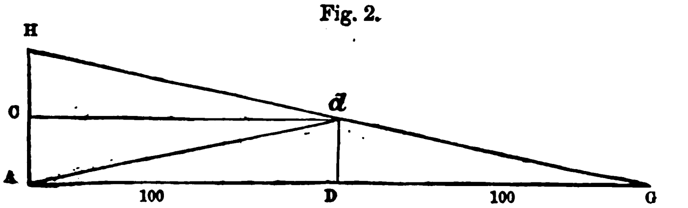


The product of the number of units of charge in each section, by the mean resistance to the passage of *each* unit of electricity constituting this charge, gives the period occupied in effecting the total charge of the respective sections. Thus, the time occupied in charging A B is $11\times1=11$; in B C, $9\times3=27$; in C D, $7\times5=35$; in D E, $5\times7=35$; in E F, $3\times9=27$; and in F G, $1\times11=11$. The total period of charge of A G will, therefore, be 146 units of time.

Let us now take a length of wire, A D, equal to one-half of A G, and make contact with earth at D. Assuming the resistance of the battery to be infinitely small, a line drawn from H to D will now represent the distribution of the tensions. The total number of units of charge accumulated in A D will be 18, equal to one-half the former charge. The distribution of the 18 units of charge will be as follows:—For C D, 2 units; for B C, 6 units; and for A B, 10 units; these numbers being in the ratio of 1, 3, 5, and equal to 18. The period of charge of A B, expressed by the number of units of charge multiplied by the mean resistance of the section, will be 10 units of time; that of B C, $6\times3=18$; and that of C D, $2\times5=10$. The total period of charge of A D is, therefore, 38 units of time.

Let us now compare the following calculation of mean resistance to each unit of charge in double and single lengths.

Fig. 2.



1. Distribution of charge on A G.

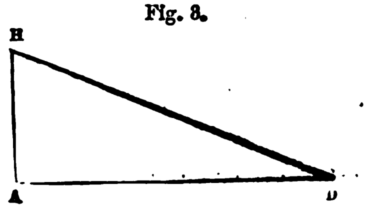
The total quantity of charge being 4 units; 3 units of electricity will be accumulated on A D, and 1 unit on D G.

To find the resistance to the charge of the section A D, multiply half its length by 3, the number of units $50\times3=150$.

The resistance opposed to the charge of the section D G is found by multiplying half its length by the number of units, and adding the product to the whole length of A D, $50\times1+100=150$.

The total resistance of A G is therefore $150+150=300$, and the mean resistance to each of its units of charge $=75$.

Fig. 3.



2. Distribution of charge on A D equal to one-half of A G, fig. 2.

The quantity of charge $=2$ units.

The resistance under which the charge is distributed is obtained by multiplying half the distance A D by number of units, $50\times2=100$.

Ratio of the two lengths 3 : 1.

There thus appears a discrepancy when we compare the result obtained from a single and a double length of wire, taking the undivided shorter one as the standard of length, with the result arrived at by calculating from two wires bearing to one another the same proportion, but first supposing them to be divided into fractional parts. In the first case the resistance of the single length is to that of the double length as 1 : 3; in the second case the resistance is as 1 : 3·84. We shall conclude the consideration of this question in our next number.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 160].

Some electroscopes are constructed with double arms, the one D C, fixed, the other, A B, moveable, and the force which eventually balances the electrical repulsion is in some cases gravity, as in Sir W. S. Harris's electroscope,* and in others, terrestial magnetism, as in Peltier's,† in both cases the balancing force is made to act in a direction parallel to the fixed arm.

Now, in these instruments, if we divide the instrument by a straight line down the centre of the fixed arm, it is evident that since each half of the instrument is precisely similar, that it is

* See "Rudimentary Electricity," page 94.
† See "De La Rive," Vol. III. page 95.

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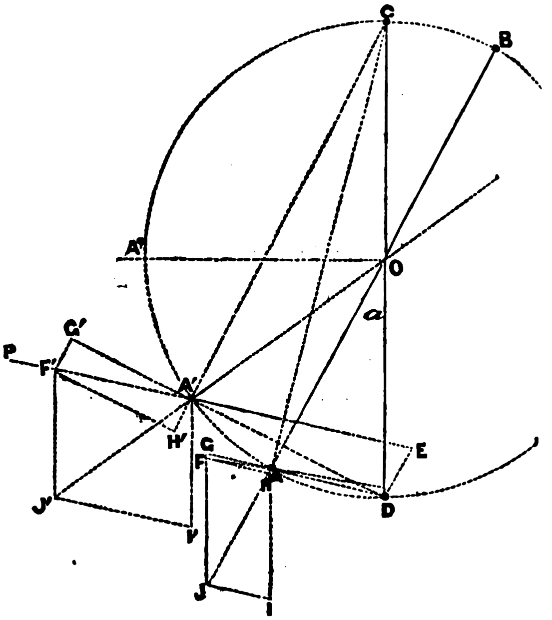
necessary only to consider the action in one half. Suppose D O C (fig. 87) to represent the fixed arm, with terminating spheres D and C, and A O to represent the half of the moveable arm, and let it be supposed, for simplicity of consideration, also, that the action is confined to an action between the spheres, as in the other electroscopes we have considered.

Fig. 87



Now, is is evident that in this instrument, unlike the others already discussed, we have two electrical forces acting on the sphere A, the one a force between D and A, the other one between C and A. These forces, it will be seen (by a well-known property of the lines inscribed in a semicircle), are always at right angles to one another, and by Coulomb's law of the relation of distance to the attractive force between small spheres, the force will vary inversely as the square of the distance.

The ratio of the two forces to one another, therefore, constantly changes as the moveable arm diverges; thus, when the moveable arm is at A the force between D and A will be to that between A and C, as A C^2 is to D A^2, and when at A′ the force between D and A′ will be to that between C and A′, as A′ C^2 : D′ A'^2. The ratio between the two forces acting on A will be the same, however, for any given position of A, whatever be the quantity acting, and, therefore, for any given position we may obtain the direction of the resultant of the two forces acting on A, independent of their absolute magnitude.

Thus, if the arm is at A′, if we take D E perpendicular to the chord A′ D, and make D E of such a magnitude that E D : D A′ : : D A'^2 : C A'^2, then joining A′ E and producing it towards P′, A′ P′ will be the direction of the resultant of the forces acting on A′. Now, the magnitude of this resultant of the two repellant forces must be such that its resultant with the force of gravity shall pass through O. If A′ I′ represent gravity, then drawing I′ J′ parallel to A′ P′ until it meets O A′ produced at J′, and drawing J F′ parallel to I A′ and cutting A′ P′ at F′, then A′ F′ is the magnitude of the resultant of the electrical forces, and since this is composed of two forces in the directions of C A′ produced, and D A′ produced, by constructing the parallelogram A′ G′ F′ H′ we get their magnitudes or the force between D and A′ is G′ A′, and that between C and A′ is A′ H′. In the same manner the force acting between A and D is A G.

The quantity on D must be such, therefore, that at the distance D A it will produce a force (which, in terms of the force of gravity A I) shall be equal to A G; in which case the same quantity on C will produce a force A H, the resultant of the two producing A F, and which again, resolved with the force of gravity, will produce A J, and this laying in one straight line with A O produces equilibrium.

If we could express A G by any trigonometrical function of the angle a (as in the previous cases) then, since D (distance) is proportional to the chord of a we could express, in trigonometrical functions of the angle a, the relation between the quantity that would be required on the sphere D to produce the force A G, and the angle a. And since this same quantity on C would also produce A H (and consequently A F) we could express, in the same manner as in the former cases, the relation between the angle a and the quantity on the instrument necessary to produce it. But this does not appear to be soluble by plain geometry. The direction of the resultant A′ F′ of the two repulsive forces varies; being at right angles to D O when the arms are theoretically closed, and also at right angles to D O when the arm A O forms an angle of 90° with D O, and forming a variable angle with D O at every other part of the quadrant. It is, in fact a tangent to the circle at D and lays in the direction of the radius produced at A″, but is in neither direction between those points.

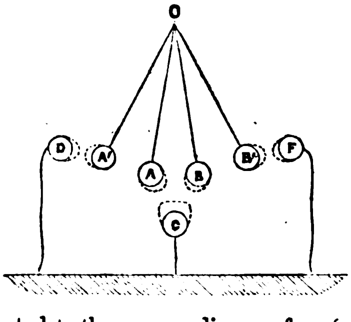
When the arm A O forms an angle of 90° with D C as at O A″, then the spheres D and C being equidistant from the sphere A, the repulsive force will be equal from both, and since these forces both act at an angle of 45° with the line A″ O, the resultant of the two forces will be in the direction of O A″ produced. And, since the force of gravity acts at right angles to this direction, the resultant of the three forces can never take the direction of O A″ produced, or, in other words, the arm O A can never form a right angle with D C however great the quantity.*

It is evident, that in each of these instruments I have alluded to, the angle of divergence varies in such a complicated ratio to the quantity on the instrument, that they are practically useless as electrometers, and indeed are, I believe, only used as electroscopes.

Moreover, it is easy to see from what has preceded, that the position of the surrounding surfaces has an important bearing on these instruments, and that unless means be adopted to keep the nearest surrounding surface at a constant and uniform distance from the charged bodies, whose repulsive force we are measuring, or observing, that force may vary without indicating any change in the total quantity of the charges on these bodies.

Thus, if a pith ball electroscope, A B (fig. 88), have conductors,

Fig. 88.



D and F, connected to the surrounding surface (or, in fact uninsulated conductors) approached to it on each side, the divergence will increase; whereas, if one such conductor, C, be approached under it, or even opposite to the plane in which the arms hang,

* Although I have failed to solve the problem of the ratio of quantly to the angle of divergence in this case, the investigation, even so far as I have carried it, is useful in showing the general principles of the instrument, and may also be of service to any one who may feel inclined to attempt the complete solution of the problem, which, probably, is only attainable by the calculus. It is curious that in no book on electricity, that I know of, is there any attempt at an investigation of the ratio between the quantity and angle of divergence of any electroscope of which gravity or terrestial magnetism is the counter balancing force. If any of the readers of The Electrician are able to inform me of any book containing anything on the subject, and would do so, I should feel obliged.

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and equidistant from each, the divergence will decrease. This effect is very strikingly illustrated with a Peltier's electroscope, if such an arrangement have a band of metal in an eliptical form placed around it, the divergence of the instrument can be altered at will by an alteration in the position of the axis of the elipse, or if an uninsulated body be approached between the divergent arms they will tend to close, and if placed outside the moveable arm the latter will tend to increase its divergence. It is evident, therefore, that the position and proximity of all the conductors in a room must affect, more or less, the results obtained with these instruments, and that, unless guarded against, this must be such a continual and varying source of error, that no two experiments performed under such circumstances, could be compared with even a degree of reliability.

This does not appear to have been perceived by some of our ablest electricians, for we find electrometers unprotected in any way from this action used in delicate experiments; and, indeed, Sir W. S. Harris seems to have observed the effect of the proximity of an uninsulated conductor to an electroscope, without either perceiving the cause or the importance of guarding against the danger; thus, after detailing the effect on his electrical balance of doubling the surface of a charged surface in connection with it, he observes :—

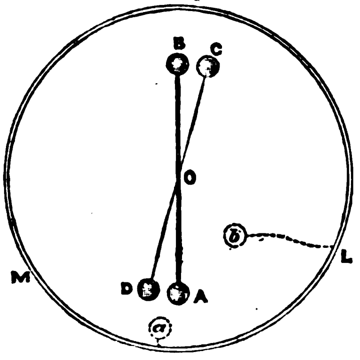
"The physical causes of these effects are not very apparent; they seem, however, to have some connection with the following fact. The force exerted between two given substances is, more or less, diminished by the presence of a neutral, or other body, sharing in the attraction. *Thus the excited balls of an electrometer tend to close when an uninsulated neutral body is brought near them.*"

The electrometer here alluded to was in principle such as represented in fig. 89, and if, when it had received a certain charge, the surrounding conducting surface were brought near to it at *a* (or even in front of D A), the inductive resistance would be least in that direction, the tendency would be to cause it to decrease its divergence, since the attractive forces between the bodies and the outer surface *a* will be in the direction D *a* and A *a*, and thus will tend to diminish the distance between the balls. Had the conductor, however, been placed at *b* the divergence would have been increased.

Professor Faraday calls attention to the effect of the surrounding conductors in many places, and particularly in his description of his Coulomb electrometer, which he enveloped with circular bands of tin-foil. "These bands," he observes, "were connected with each other and with the earth, and, being perfect conductors, always exerted a uniform influence on the electrified balls within, which the glass surface, from its irregularity of condition at different times, I found did not."

If, however, we maintain the distance between two similarly and equally electrified bodies constant, maintaining also the nearest surrounding conducting surface at a constant distance,

Fig. 89.



then, by measuring the force with which the charged bodies tend to separate, we may arrive at the proportionate quantity which is communicated to them, and which will be (by the law of quantity and attractive force) as the square roots of the forces.

Let A B (fig. 89) represent a fixed and insulated arm supporting two small conductors, A and B; and let D C represent a similar, but moveable, arm in conductive connection with A B; the whole being surrounded by a metallic case, M F L. Then, if a charge of electricity be communicated to those arms, a repulsive force between them will result; if, now, instead of allowing the moveable arm to be repelled, it is kept in position by some measurable mechanical force, such as a torsion arrangement, we have the means of ascertaining the proportionate quantity which is communicated to the instrument in successive experiments. Such an instrument is, therefore, a true electrometer.

(To be continued.)

ON THE ELECTRICAL LAW OF DISTANCE.

BY RICHARD LAMING, M.R.C.S.

AUTHOR OF "STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY."

So far as the interests of telegraphy, or even the requirements of the minute investigation of practical electricity in any shape, are concerned, the particular ratio in which electrical attraction varies with distance might, perhaps, be left uncared for; for the simple reason that all our operations are conducted within the boundary of the earth's atmosphere, and, therefore, under circumstances in which electrical attraction must inevitably act among particles of matter immediately contiguous to one another. Faraday first opened the eyes of electricians to the agency of atmospheric air in propagating electrical attraction, by his twelfth series of Experimental Researches, read before the Royal Society in February, 1838, while the writer was revising an essay, published in the *Philosophical Magazine* for June of the same year, and bearing date in April, in which the propagation was attributed to the definite character of the electrical attraction. Since that time, neither the functions performed by the air in sustaining induction, nor the definite character of the attraction which causes it to be propagated, has been called in question; and as one so well accounts for the other, and the two are in perfect harmony with all other electrical facts without exception, both have a claim to be considered as established.

Now, one of the immediate consequences of those two doctrines is, to give us, geometrically, the law of the inverse squares of the distances. The very careful experiments of Coulomb with charged spheres, which established it as a law of phenomena, and led him to regard it as a law of electrical force, are supposed to be accurately performed; Sir William Snow Harris, after experimenting with great exactitude upon the same subject with discs in connection with a Leyden jar, came to the same conclusion as Coulomb, and wrote :—"Thus, whilst the distances became 1, $\frac{1}{2}$, $\frac{1}{3}$, &c., the forces became 1, 2^2, 3^2, &c., that is to say, they increase in the reverse ratio of the squares of the distances." Upon these latter experiments Mr. Webb is now remarking,—"I have shown that the quantity on the discs would be halved when the distance was doubled;" and with reference to the former he says, "these results do not in the least establish the relation between the attractive force at different distances. For it is evident that as the spheres are separated, a redistribution of the electricity on each sphere will result." In all this an effort is being made, it might be supposed for the first time, to reason away the evidences of Coulomb's law as a law of force.

I have more than once wished my contemporary to take counsel from the "Steps to Theory," which, he will see, if he refer to the number of the *Magazine* I have mentioned, I am not recommending to his attention without having taken due time for reflection. I am not very careful to contest for the merit of originality, nor do I think Mr. Webb will claim it after reading a paragraph or two from the "Steps." "So far as we at present know, we do not require to regard the law of Coulomb as a normal law of electrical

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force; the ratio of the inverse square of the distances has been derived from observations taken under circumstances in which the ratio admits of explanation without it; and instances are not wanting to show that it is untrue under other circumstances in which, if it were a law of force, it ought to obtain also. We purpose to make no use of it," par. 65. "Our present purpose is to demonstrate that the inverse squares of the distances result from the electrical law of quantity, irrespective of distance," par. 156. I would also quote par. 156, as showing *how* they result, if it were not too long; but it can easily be found in its proper place.

But what I have chiefly to do with in this memoir is of more importance to the electrical public than the law of Coulomb, or the date of its being called in question: with every desire to leave Mr. Webb at leisure to pursue his own particular views, I must protest against *his requiring us to doubt an inverse ratio of electrical attraction altogether.* To be quite sure of not misrepresenting his meaning, I will give it in his own language: "Now if the quantity on the discs was halved, as I have endeavoured to show it would be, when the distance was doubled, then the attractive force should be reduced to one quarter, even if the distance could have been maintained unaltered with this alteration in quantity; and, as it *was* reduced to a quarter, although the distance was doubled, this seems to indicate that if equal quantities of electricity actually act on one another, *their attractive force is not altered by distance,*" Electrician No. 37, p. 124. And again: "It is, I maintain, therefore, open to speculation, whether the alteration in attractive force is not entirely due to this alteration in the quantity attracting, by the redistribution thattakes place in each case, and that if the quantity attracting is maintained constantly the same, the attractive force would not vary with increase of distance."

Mr. Webb will think it only reasonable that I record my opposition to such a doctrine until he can find time to explain on what principles of physics, attraction can be a force acting to diminish distance, and yet be physically indifferent to distance.

So far as the facts are concerned, nothing could be more easy than to show by experiment that "the alteration of the distance between the discs" does "alter the quantity almost accurately inversely as the distance," as predicted by Mr. Webb, as well as by the general theory of definite electrical attraction. This coincidence in prediction may at first appear remarkable, until it be recollected that *the calculations are based in both cases upon the quantity of air present*, it being assumed in one case to be supporting induction, and in the other to be resisting it; two opposite means for describing the same thing, the only difference being, that the latter is the less direct of the two. It is only, however, in certain cases that this coincidence exists between Mr. Webb's theory and my own, as his fails altogether to meet the facts introduced by variable densities of the air, while mine embraces them.

Another thing predicted by the definite theory is that the projected experiment represented by fig. 83, in the 39th number of The Electrician, will not answer the purpose for which it was designed; that is, of proving the forces of attraction between A C and A D to be equal; according to the theory, their equality is an impossibility. The quantity of charge on the surrounding shell will be the same whether it be nearer or further off; but inasmuch as in the latter position it will be distributed over a larger surface, and as the attraction is inversely as the square of the distribution, it will become one-fourth at a double distance.

As I have had occasion to allude to my early memoir on "The Primary Forces of Electricity," in which I treated of the cause of the propagation of electrical attraction, it may avoid misconception if I here quote from it part of its concluding paragraph, with its foot-note. I do so with some apprehension, because it is one of those cases in which an author can hardly attempt to do justice to himself, without appearing to covet what he is freely willing to admit belongs to another by priority of publication, if not also by priority of conception. The italicisms are in the original.

"65. But what I have more particularly to state here is, that it will be seen in the pages which are immediately to follow, that although the law of Coulomb accurately expresses the *sensible effects* of the action of electricity on common matter in general, we have not on record a single instance of that action that may not be minutely and circumstantially traced to matter at *insensible* distances.*

"*London, April* 17, 1838."

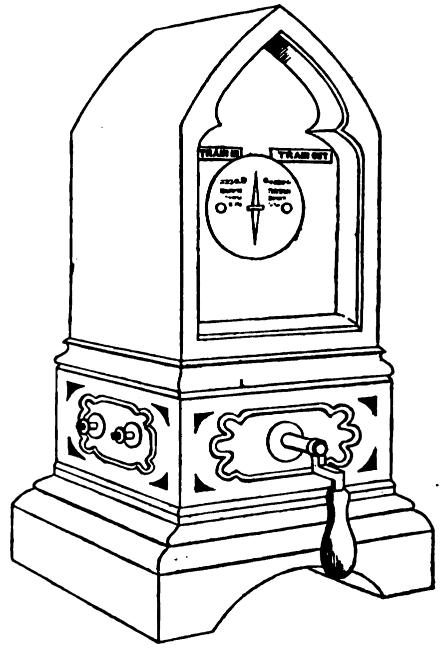
ON RAILWAY TELEGRAPHS.

BY W. H. PREECE, ASSOC. INST. C.E.

Most railway companies, in working their long tunnels, &c., employ simply a single needle speaking instrument, which, by a momentary deflection on one side or the other, gives the information of the entry or exit of a train. This is a primitive and faulty system, by no means safe, and anything but creditable to those who have the management of railways.

Perhaps nine-tenths of the tunnels possessing telegraphs are worked on this principle. It is that which was used at the Clayton tunnel. It is that which is used at too many other tunnels which could be mentioned.

Fig. 8.



The above figure shows the instrument most generally employed:—one beat to the left signifies "train in," one to the right "train out." It is used indiscriminately for both up and down lines. It can also be used for conversational purposes.

When a train enters a tunnel, the signalman, at the end which it enters, telegraphs to the man at the opposite end, "train in;" and when the train arrives at that end, the man there signals back "train out." The danger signal is raised while the train remains in the tunnel. No second train is allowed to enter until the first train has been signalled out.

It might be considered that the simple information of the presence of a train in a tunnel was sufficient to enable a signalman to work his signals, and prevent the entrance of a second train upon the same set of rails; but in the multifarious duties

* "Since these pages have been in the hands of the printer, I have been favoured by a sight of the forthcoming series of Dr. Faraday's admirable "Researches;" in which that assiduous and successful philosopher labours to prove by experiment that electrical induction is transmitted to distant bodies by intervening matter. How well this experience accords with the new theory, will more fully appear in the ensuing part of this paper."

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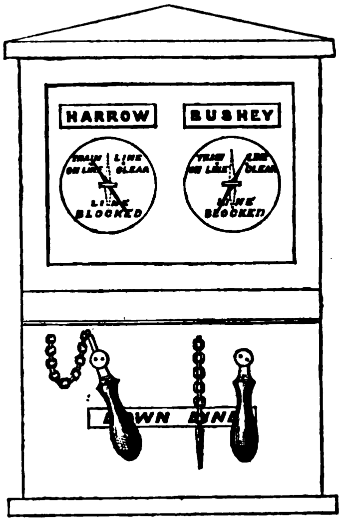
which crowd upon a signalman, when two or three trains are passing and approaching on different lines at the same time, it is well nigh impossible for him to retain on his mind the simple momentary movement conveyed by a slight delicate needle. Perhaps another train enters the tunnel at the other end, and is signalled at the same time. It arrives, is signalled out, and another signalled in before the first is out. The signalman gets confused, he has recourse to conversation, confusion becomes more confounded. He admits a second train on the wrong set of rails. An accident occurs, with all its sickening horrors and lamentable results. This primitive telegraph is then discarded, and a more improved system adopted. But other companies, in other parts of the country, remain obdurate. The old system is continued, until another sad accident teaches them the same dearly-bought experience. The Clayton tunnel telegraph worked satisfactorily for ten years, but it failed at last.

This system was considerably improved by Mr. Edwin Clark (M. Inst. C.E.) upon the London and North Western line. He perfected the original scheme of Mr. Cooke. Each set of rails has its own independent telegraph and out-door semaphore. The semaphore is regulated by the telegraph. It thus becomes a distant signal worked by telegraph. The instrument used not only shows when the line is clear, and when it is occupied, but it also shows when an accident occurs, and when the line is rendered

Fig. 4.



CLARK'S SIGNALLING INSTRUMENT.

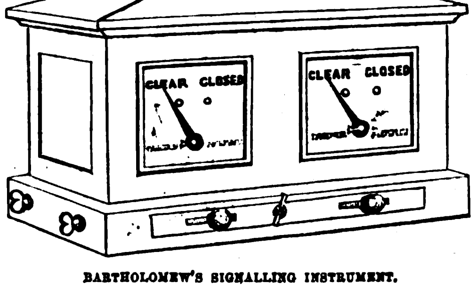
impassable. The instrument employed is the original double needle instrument of Mr. Cooke. A deflection on one side signifies "train on the line," on the other side "line clear." Constant currents of electricity are maintained on the wires by pegging the handles over, as shown in figure 4, so as to keep either one of these signals constantly visible. The instrument always shows either "train on the line," or "line clear," but if the current is cut off, the needle becomes vertical, and produces a third signal. This third signal signifies "line blocked and impassable," and that an accident has occurred. It is produced by rupturing a small wire that descends down every alternate pole on the line, within the reach of the guard or driver of the broken down train, and thus enables him to signal his discomfiture to either side of him. Thus when a breakdown occurs, instant warning of danger is afforded to each station on either side of the disabled train. This is an ingenious contrivance, but it is questionable whether there is any advantage in its adoption. Captain Tyler recommends its use in his report on the Clayton tunnel accident, but it is believed that the North Western Company have abandoned it in their recent extensions. These disconnecting points cause many interruptions to the working of the circuit, and their original construction is costly. Every point, offering the slightest probability of accident to an electrical circuit should be carefully avoided, and particularly so when the circuit becomes such a guardian of safety as a signalling telegraph. The means at present adopted (fog signals, red flags, &c.), are quite sufficient to stop any advancing train; and the spaces into which the line is divided should be of such a length that no great time should be wasted in conveying intelligence of the breakdown to the nearest signal hut. The London and North Western railway, between London and Rugby, is divided into spaces, averaging a little more than two miles in length. This is sufficiently close to avoid the necessity of these dangerous disconnecting wires.

It must be observed that in working this system on the London and North Western line, that company do not strictly adhere to the regulations laid down by Mr. Clark. They allow two, three, and sometimes four trains to be on the same length at the same time, excepting in the case of tunnels intervening, and the signal "train on line" is simply accepted as a cautionary signal. The vertical needle alone is accepted as the danger signal. This is not considered sufficient under all circumstances to prevent collision. The company believe that they cannot work the line if they invariably maintain a distance of two miles between their trains; but if two miles is too great a distance, why not adopt a shorter length? If a shorter length is not practicable, then a third set of rails becomes imperative. The system in use on the London and North Western line is undoubtedly a wise precaution against accident, but it is by no means a certain element of safety from collision. Were it strictly carried out, as originally contemplated, it would undoubtedly be so.

The instrument employed by Messrs. Cooke and E. Clark, and, indeed, that most generally employed for railway signalling purposes, is the needle telegraph. Its signals, except in the case of the block system, are transitory, and, therefore, dependent upon the memory. They are liable to be reversed by the action of lightning, and "line clear" may be sometimes given for "train on line"—"train in," for "train out." It is, moreover, capable of being employed as a speaking telegraph, which is extremely objectionable in a telegraph employed solely for the regulation of trains. If a telegraph is required for conversational purposes, and this is invariably recommended by the Government Inspectors, a separate wire should be erected for that object; but the telegraph employed to regulate the distant signals should never be used for any other purpose. The Clayton tunnel telegraph is a remarkable instance of the danger of conversing upon the signalling telegraph. Confusion arose, and the accident ensued.

These objections to the needle telegraph are avoided in Bartholomew's and Tyer's system. Bartholomew's system is employed on the London, Brighton, and South Coast railway. Tyer's on the North London, South-Eastern, and several other lines.

Fig. 5.



BARTHOLOMEW'S SIGNALLING INSTRUMENT.

Each instrument has an indicator for each set of rails, with two signals, the one signifying "line clear," the other "train on line." The deflections are constant, and can, therefore, as in

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Clark's, be referred to at any moment. This constant indication is maintained in Bartholomew's by gravity—in Tyer's by permanent magnetism. The adoption of gravity to produce constant deflection is a mechanical fault in the construction of Bartholomew's instrument, which renders it, in some respects, inferior to Tyer's. Tyer's (as well as Clark's) instrument has, also, the advantage, that the signal at one station can only be altered and maintained by the man at the distant station. Each of these systems is based upon the block principle originated by Mr. Cooke. Tyer's system has been fully described and illustrated in The Electrician, *vide* Vol. i. p. 285. It has been highly eulogised by the Board of Trade, and various railway companies, and is extensively used. It is, I think, superior to Bartholomew's, and I should be inclined to adopt it in preference to Clark's, were it not that Clark's instruments are so simple in their construction, that the most ordinary and stupid switchman can, with a little tuition, easily remedy any fault that may arise. Tyer's instruments, moreover, are liable to be affected by atmospheric electricity. Next to efficiency, simplicity is unquestionably the most admirable attribute in a railway telegraph, and economy follows closely in its wake; and if we examine these different systems as regards their efficiency, simplicity, and economy, I think that Clark's must be pronounced the best. It is difficult to determine which is the superior of the other two. Both are admirable in their way, and fully accomplish the object for which they are required; but, still, they do not meet all the requirements of the railway service. The railway electrical signalling apparatus, *par excellence*, has not yet been introduced.

There are other systems at work on other lines, which differ in some respects from those I have mentioned. In France a system similar to that on the Brighton line is much used. On the Great Northern line the needle block instrument is employed, but a warning signal in the section in advance of that upon which the train is running, is adopted to signify that a train may be expected and attention maintained. On the South Eastern line, Mr. Walker has introduced a system of bells, which effect by sound what on other lines is produced by sight. A somewhat similar plan is adopted in Germany; but they are all more or less modifications of the same principle, viz., that of rendering distant stations distant signals regulated by electricity, and of giving warning of the approach of a train some miles ahead. Electricity thus practically renders the sound of the whistle audible miles away from the train, and enables distant signals to be worked and regulated to any distance. Properly applied and properly used, it is difficult to conceive how accidents can possibly arise.

Bells are employed on all these systems, but as they all effect the same purpose—attracting attention—and sometimes affording information as to the nature of the train, they have not been alluded to.

Record books, or slates, in which the times of starting and passing of all trains are entered, in ruled columns, accompany most of these systems, and are essential elements of attention and regularity. Captain Tyler says, "A man is obviously unlikely to commit an irregularity of any sort in duties of this description, when he is himself compelled to make a permanent record of it, liable at any time to be brought against him, open to observation on periodical or irregular inspections, and checked by other records, made by responsible officers within a short distance, and perhaps on both sides of him." Such record-books should invariably accompany signalling telegraphs. Few lines now omit to avail themselves of their use.

(*To be continued.*)

ON SOME NEW PHENOMENA OF RESIDUARY CHARGE AND THE LAW OF EXPLODING DISTANCE OF ELECTRICAL ACCUMULATION ON COATED GLASS.

BY SIR W. SNOW HARRIS, F.R.S.

[Continued from page 165.]

In considering the nature of electrical accumulation on coated electrics, and the law of explosive discharge, we have to deal with a simple question of physical force taken in the abstract, and not with a theoretical electric fluid or fluids of high elasticity, subject to expansion or contraction, changes in thickness of stratum, tension, density, and the like. The terms "tension" and "intensity," so commonly applied to designate degrees of electrical force, are convenient and not inappropriate terms when legitimately applied and limited by definition. The term *intensity* is well adopted to express the attractive force of the charge in the direction of the electrometer, and which, in continually *increasing* according to a known law, terminates in explosion. The intensity or attractive force varies with the square of the charge. The term "tension" is more especially applicable to the constrained state of the dielectric particles sustaining the induction necessary to the charge, and is equivalent to the reactive force of the particles in an interrupted circuit of discharge to break down or reverse the polarized state of the dielectric medium impeding discharge, as between the exploding balls of the Lane's discharger: this is as the quantity of charge directly. In employing these terms, the author has not the least view to any specific changes in the quality or condition of the accumulated electricity, as relating to density, elasticity, and such like. Whether the tension and intensity of a charge, as evidenced by the electrometer, be great or little, he conceives that the nature of the force and its mode of operation remains the same. Viewing the process of electrical accumulation and discharge in the Leyden jar as the result of certain powers or forces operating either immediately through the glass or through an external circuit, or both, we may readily imagine that at the critical point at which the forces in the two directions become balanced, and at which point the equilibrium of charge is, as it were, overset on the side of the exterior circuit, then it is that residual charge ensues, either by a momentary revulsion of force between the coatings in the direction of the intervening glass, frequently causing fracture, or otherwise by a retention of some of the charge in that direction at the instant of explosion. Some instructive and important experiments by Mr. T. Howldy are here quoted in support of this conclusion, from the pages of the *Philosophical Magazine* for the year 1815. A ruptured jar had the coatings removed from around the perforated part, so as to admit of the jar receiving a given amount of charge. When explosive discharge took place in the usual way, a spark was observed to pass at the same instant between the coatings through the perforation in the glass, evidently showing an exertion of force in that direction. This spark is entirely independent of the discharge of the circuit, the force of which remains the same as if no such perforation existed, as Priestley and other electricians, and Mr. Howldy himself, have fully demonstrated.

Considering the question of residual charge as bearing materially on our views of the nature of electrical force, the author seeks to investigate, by new forms and kinds of experiment, the relation of the residual quantity to the whole charge, whether accumulated on glass coated with very perfect conductors such as the metals, or otherwise with less perfect conductors, as water, or with imperfect conductors, such as paper, linen and the like. The instruments employed are now enumerated and commented on, and their experimental arrangement figured and described. They consist of the electrical or Leyden jar; Lane's improved electrometer; the hydrostatic electrometer as recently perfected; the thermo-electrometer; quantity or unit measure; and battery charger and discharger. The following is the course which the author pursued in his inquiries, through the medium of these instruments.

The quantity of charge being given, its intensity is measured by the hydrostatic electrometer in terms of attractive force at a constant distance, suppose at distance 1 inch. This is first noted: the jar is now discharged through its exploding distance by completing the circuit through the Lane's discharger. The hydrostatic electrometer, being now made perfectly neutral, is again brought into connection with the inner coating of the jar. The intensity or attractive force of the residuary or remaining charge is now noted; but as this force is necessarily small, it is taken with the attractive plates at a diminished distance from ·1 to ·3 of an inch or more, as the case may require, and subsequently reduced to the standard distance of one inch, taking the force to vary, as demonstrable by the electrometer, as $\frac{1}{D^2}$. This being determined, the relative quantities of electricity in the full charge and the residual charge will be as the square roots of the respective attractive forces or intensities; the total force, as also demonstrable by the instrument, being as the square of the accumulation. Let, for example, the quantity of charge communicated to the jar be 100 measures, and the attractive force, or intensity at distance one inch, be 144 degrees, and suppose intensity of residual

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force at the same distance = ·08. In this case we have the simple proportion 100 measures : x measures : : $\sqrt{144}$: $\sqrt{\cdot 08}$: : 12 : ·283 and quantity of residual electricity $= \frac{100 \times \cdot 283}{12} = 2\cdot 35$ measures nearly; so that of the original 100 measures of charge communicated to the jar, rather more than $\frac{1}{40}$th remains undischarged in this case.

The author here offers some explanatory observations on the relative dimensions and extent of coating of the unit of measure, and the relative value of the measures quoted, and he thinks if electricians would agree to recognize a standard instrument of this description, it would be attended with very considersble advantage, as in the case of other standard instruments. The unit of measure he employs exposes about 9 square inches of coating; it is about 4 inches long, ·8 of an inch in diameter, and $\frac{1}{20}$ of an inch thick; distance of exploding balls, ·05 of an inch. Similar observations were applied to the thermo-electrometer, the ball of which is 4 inches in diameter, and has a wire of platinum through it of ·01 of an inch in diameter. The dimensions of the attracting discs of the hydrostatic electrometer are also noted, which in these experiments were 4 inches in diameter; the suspended disc weighs 82 grains. The discs are carefully gilded; 5 degrees of the arc of measure represents a force of 1 grain—that is to say, a weight of 1 grain added to either side moves the index 5 degrees of the scale. Having offered these preliminary remarks, the author proceeds to the following experiments :—

Experiment 1.—Variable charges, amounting to 50, 100, 150 measures, were successively accumulated on different jars, exposing from two to six square feet of coating, and the residual charges due to each noted; these were found to be as the total charge. Thus the residual charge for 100 measures was in every case double that for 50 measures.

In a succeeding table are noted—measured charge; exploding distance; intensity at distance 1 inch; residual measures and thermo-electric effect of discharge. It appears by this table that residual charge is as the total charge; exploding distances, as the quantity, or very nearly; intensities and thermo-electric effect of discharge, as square of the quantity or number of measure accumulated.

The author finds that for every metal-coated jar, whether large or small, of thick or thin glass, exposing from 1·5 to 6 feet of coating, the residual charge, or quantity left undischarged, varies between the limits of $\frac{1}{30}$th and $\frac{1}{50}$th of the total charge.

Experiment 2 investigates the effect of thickness of glass. Two jars, exposing 2·5 square feet of coating, were employed, their relative thickness being as 1 : 2—that is, $\frac{3}{20}$ths and $\frac{6}{20}$ths of an inch; 100 measures were accumulated and discharged at their respective exploding distances. The following results appeared :—exploding distance, directly as thickness of glass; intensity or attractive force in direction of electrometer, as square of the thickness; residuary charge in each case, the same, being about $\frac{1}{45}$th part of the total charge; thermo-electric effect of discharge, very nearly the same; so that, whether discharged from thick glass or thin, under intensities of very different degrees, the same quantity of electricity produces the same effect. The intensities in this case were as 4 : 1, yet the thermo-electric effect did not differ more than one or two degrees, one being 12°, the other 13°. The author finds, by numerous experiments on a series of jars, that the intensity indication has no influence on the force of discharge, the quantity discharged being the same. In a series of jars of different magnitudes, and in which the intensity of a given charge of 100 measures varied between the limits of 100 and 1000 degrees, there did not appear a difference of more than a few degrees amongst the whole; the effects varied between 8 and 11 degrees. Some little difference will generally arise in favour of electricity accumulated on a small area of coated glass; in consequence of the greater facility of discharge, the accumulation has greater freedom of operation through the external circuit, as is shown by its greater effect on the electrometer.

A celebrated electrician, the late Mr. Brooke, of Norwich, in a conference with Cuthbertson about the year 1800, stated that a Leyden jar, coated with strips of metal $\frac{3}{4}$ths of an inch wide, leaving intervals of the same width between the strips, was equally efficient as a full coating in the ordinary way. Two equal and similar jars, about 1 foot in diameter, and 19 inches high, were prepared accordingly; one fully coated to about 4 square feet, the other coated in strips to about 3·5 square feet. The author, although doubting this statement in all its generality, still considered an investigation of it, more especially coming from such men as Brooke and Cuthbertson, desirable, and as being calculated to throw further light on the phenomena of the Leyden jar.

A few preliminary experiments seemed to accord with Mr. Brooke's view; the exploding distance of the two jars with a given charge did not appear extremely diffeient. The accumulated electricity spread upon the glass between the strips of metal, and thus enabled the partially coated jar to receive a larger accumulation, upon the principle stated by Cavendish, than was really due to its extent of actual coating. Mr. Brooke, in the then state of practical electricity, might have been, therefore, easily led to imagine that a partial coating such as he describes was sufficient. It is, however, shown in this paper, that the cases of the two jars are widely different. As the spread of the electricity becomes satisfied, a less charge is required for explosion, and the tension of a given quantity increases. The following are the results of experiments with 100 measures similar to the preceding :—

Full coating.

Exploding distance	·15	Intensity 100° at 1 inch.
Residual measures	2·45	Therm. electric effect 8°.

Partial coating.

Mean exploding distance ...	·25	Intensity 160°.
Residual measures	4·95	Therm. electric effect 3°.5.

It is evident the two forms of coating are not equally efficient, the heating effect of discharge not being half as great in the partially coated jar, whilst the residual charge is twice as great. The experiment so far shows the spread of electricity on the uncoated glass to be a source of absorption of charge to a greater or less extent, and goes far to confirm the views of Mr. Cavendish, relative to the spreading of electricity on glass.

The phenomena of metal-coated jars having been so far examined, a similar course of experiment is followed with jars coated with less perfect conductors, commencing with water coatings. For this purpose, a jar exposing nearly 5 square feet of coating, was prepared with was prepared with metal coating, and the results of a charge of 100 measures determined and noted as before; the metal coating being removed, the same jar had an equal extent of water applied to its opposite surface coating. The method of effecting this is described. The author states that it was so perfect as to shield the experiment from all interference of vapour from the water surface, so that the jar completely retained the charge withoutany dissipation, and in no sense differed in this respect from a metal-coated jar.

The results of this experiment are not a little remarkable. The exploding distance of the 100 measures, whether with the metal or with the water coating, did not materially differ, except in apparent force, being for the metal ·22, for the water ·2. The exploding spark from the water coating, instead of the sharp ringing sound attendant on the exploding spark from the metal coating, is weak and subdued, and is often like the sound of fired damp gunpowder. The intensity, or attractive force, is also in each case alike, or very nearly; being for the metal coating 144°, for the water 142°. The residuary charges differed considerably, being for the metal coating about 2·25 measures, or about $\frac{1}{45}$th part of the total charge; for the water coating 14·5 measures, or about the $\frac{1}{7}$th of the total charge. The residuary charge with a water coating is more than six times as great as with a metal coating. The thermo-electric effect with the metal coating was 10°, with the water coating nothing; 200 measures, or double the charge, had no effect on the thermo-electrometer.

In this experiment it does not appear requisite that both the coatings should be water; one coating may be metal, as in the first forms of the electrical jar. The author could not, at least, discover any material difference in the results, and concludes that if the first forms of the electrical jar with an internal coating of water had been continued, we should have had but small experience of the effects of artificial electrical discharge on metallic wires.

Imperfect conducting substances employed as coatings to the electrical jar have very similar but very exaggerated effects. With coatings of paper we have a striking example of retention of charge. A jar exposing 5·5 feet of coated glass, first coated with metal, and subsequently with paper, gave the following results under a charge of 100 measures.

Exploding distances as in the former case, nearly the same, being ·23 and ·25; attractive forces or intensity also nearly the same, being 158° and 160°; residual measures with the metal coating 2·5 measures, or about the $\frac{1}{40}$th of the total charge; with paper coating, in some experiments 80 measures, or about $\frac{8}{10}$ths of the total charge, so that the residual charges with metal and paper, are as 1:32. Thermo-electric effect for metal coating 8°, for paper coating nothing. It appears from these and similar experiments, that the interposition of imperfect conductois between the coating and the glass of the Leyden

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jar, must necessarily impair its efficiency, and change its electrical indications, especially when of any considerable thickness. Three turns of common linen interposed between the outer coating and the glass, reduced the force of discharge from 11° to 6°, nearly one-half, whilst the residuary or retention of charge is considerably increased: this question, as bearing in some degree on the retention of charge by the electric cable, may not be undeserving of further investigation.—*Philosophical Magazine.*

THE INDUCTION COIL.

The following observations on the induction coil were published some years since by Mr. W. Ladd, in the *Mechanics' Magazine.*

"Having been rather extensively engaged for the last two years in the manufacture of induction coils, and having received the constant and able advice of J. P. Gassiot, Esq., and the practical suggestions of Mr. C. A. Bentley, I have thought that a brief description of the machine as it is now made, with the results obtained, may not be uninteresting. My object has been, not to make very large machines, but to obtain the greatest results from a three-inch coil, that being sufficiently large for all ordinary purposes. I find the best length for the iron core to be 13 inches, and about 15·8 diameter, composed of fine iron wire, not larger than No. 22, very carefully annealed. The primary wire should be of sufficient size to carry freely the whole of the battery current, and of sufficient quantity to thoroughly saturate the iron core with magnetism. For this purpose I use three layers of one continuous No. 12 copper wire, carefully annealed; if more layers are used, I find that the secondary wire is removed too far from the magnetic influence. The secondary wire ought not to be larger than No. 36, covered with silk, which must be laid on perfectly even, and insulated from the primary wire, and also from the layers of the secondary next to it. I find the best insulating medium to be the thinnest gutta percha made, and which I believe to be the only gutta percha sold which cannot be adulterated; it is true that it has many minute perforations, but by laying on at least six thicknesses between each layer of wire, perfect insulation is secured. The greatest care must be taken in protecting the ends of the layers, so as to prevent sparks passing from one to the other. The condenser should be at least 50 sheets of tin-foil, of about one square foot in size. These sheets must be separated from each other by three sheets of varnished paper or gutta percha tissue. Every alternate sheet of foil is connected together, thus forming two poles to be attached one to each side of the break. It may be placed at the bottom of the stand, or in a separate box; the latter I prefer. In developing the power of the machine, everything depends upon the contact-breaker, which should be capable of retaining contact until the whole of the magnetism is obtained, and capable also of breaking contact as soon as the smallest quantity is induced. These results (capability of regulating the break) are obtained in the break attached to this instrument. The hammer is made to vibrate freely between the iron core and the coil, and the brass screw terminating with the platina plate at the back of the hammer. A very small amount of magnetism will be sufficient to attract the hammer, and so break the contact. If, now, I bring the screw placed half-way up the spring, carrying the hammer to bear upon the spring, it will have the effect of pressing the two platina plates together; so that it takes a greater amount of magnetism in the iron core to separate them. By this means I can regulate the power of the instrument to the purposes for which it is required. The battery I employ is a 5 cells of Grove's, with immersed platina plates 5×3, having an exposed surface of 140 square inches. With such a battery, and a coil thus constructed, I can always insure sparks from half-an-inch to four inches in air. The machine now exhibited contains 6 miles of wire, and, worked with the same battery, gives 6¼-inch sparks. The position which the induction coil is now taking in this electrical age is one of considerable importance. It has awakened new philosophical ideas, and is being successfully applied to practical purposes of the highest advantage to mankind. For blasting purposes, a three-mile coil is capable of firing fifty charges simultaneously. But, important as its present position is, and successful as its past application has been, it is yet in its infancy, and there can be little doubt that, by *patient perseverance,* machines can be constructed that will obviate the necessity for employing such ponderous machines, and still more ponderous batteries, as are now at work on the Atlantic cable."

IRON COVERED CABLES.

[Continued from p. 153.]

We now place before our readers the opinions expressed by several of the speakers at the discussion on Mr. W. H. Preece's paper, read at the Institution of Civil Engineers. We have now before us a portion of the Red Sea cable, in which, for a full yard in length, the iron wire is completely eaten away, leaving the core solely protected by the hemp, which we find remains in excellent condition.

Mr. W. H. Preece:—"The want of coating to retain unimpaired the strength of the cable, was exemplified in the case of some of the recent failures in deep sea cables, and particularly in that of the Atlantic cable. Had the latter been protected against the action of sea-water upon the outer wires, its repair would have been easy, and the transmission of messages across the Atlantic would now be in full operation. The report of Mr. Varley showed that the wires had become so decayed as to be incapable of repair, whilst those parts which had been coated with hemp, were as good as when the cable was first laid. Again, in the case of the Red Sea cable, he had heard that those who undertook the repairs, found the cable, when brought to the surface, similarly decayed. Some cables, however, had been made which partially carried out the ideas he advocated; the one most recently laid was the Toulon and Algiers cable, which had a covering of hemp."

Mr. C. W. Siemens:—"He could refer to several cables which had remained perfectly sound for a certain distance, but had been in some places so completely corroded, that in attempting to repair them, they literally fell to pieces, such had been the case, as had been already mentioned, with the Atlantic cable."

Mr. C. F. Varley:—"He had seen parts of the iron wire of this cable where it was covered with hemp saturated with Stockholm tar, which had retained its brightness after having been immersed in the sea for a long time, a result attributable, he believed, to the preservative properties of the tar rather than to those of the hemp. The portions not so protected were found to be corroded to such an extent, that it was not possible to raise the cable without constantly breaking the thin wires of which the outer covering was composed."

Mr. C. W. Siemens:—"So far from the iron being an element of strength, it became an element of absolute weakness when the cable required to be raised for repairs. It had frequently been observed that the iron was oxidized, and in certain parts rapidly destroyed; and if the ground was uneven the cable would then break by its own weight between the points of support. But the outer coating should not be of hemp, for there had been cases of hemp-covered cables being completely destroyed by marine animals."

Admiral Fitzroy:—"With regard to the manner in which submarine wires had been hitherto supposed to be protected when at the bottom of the sea, he maintained that iron should on no occasion whatever be employed as a covering or armour."

"He had been told by Mr. Park, formerly Master-Attendant of Portsmouth Dockyard, that they were obliged to lift the chain moorings throughout the harbour at least once in about four years, because in certain places the cables became so corroded that they could no longer be trusted."

"In the Bay of St. Blas, 40° south latitude, between the Rivers Plata and Negro, a ship lay two months moored by chain cables, one of which was found to be so corroded in that short time from lying across copper ore, cropping out, and exposed as rocky patches or ridges, that the cable was condemned, even in a merchant's ship."

Mr. Latimer Clark "Would confine his remarks to a statement of his own experience, which might be more useful than theoretical opinions. Submarine cables for shallow water might be comprised under four classes. First, the hempen cable; secondly, the galvanized iron cable; thirdly, the unprotected iron cable; and fourthly, the iron cable with some protecting covering. With respect to the hempen cables there were mechanical defects sufficient to condemn their use, as in the few attempts that had been made to lay them in shallow waters, they had soon been destroyed by the continued action of the tide and of the rocks. Galvanized iron cables of many hundred miles had been laid from the English coast, had proved wherever they had been embedded in mud or sand, to be very durable, so much so, that some specimens which had been under water during four or five years looked so bright and new that it was scarcely possible to believe that they had been submerged at all. He considered galvanized iron cables buried in mud or sand, might last fifty years, or sixty years, or perhaps more; but wherever they were exposed to the free action of the tide, corrosion was certain to occur. Judging from his experience, galvanized cables had, in all cases, a durability of at least three years beyond that of unprotected iron cables, but after that time the zinc gene-

rally disappeared, and all cables, whether originally galvanized or not, were alike acted upon by the sea water. This corrosion was conjectured to result from the cable lying upon copper ore, or some other material, which was electro-negative with respect to iron. Sulphuret of copper would cause a galvanic action, and the iron would soon be corroded. Cables were often quite perfect for a great length, and then suddenly there was a spot where a piece had been, as it were, carved out of the cable by some local corrosion; in some places the iron had disappeared altogether, and nothing was left but the hemp and gutta percha. If there was copper in the sea water it would be deposited on the iron in the metallic form, and galvanic action would immediately commence.

The first cable between Hurst Castle and the Isle of Wight, which was laid only five or six years ago, became in eighteen months so deeply corroded at places, from the action of the copper, or of some other material, that it was broken by a ship's anchor. This was replaced by a smaller cable, which did not last a year, and subsequently by a third of stronger construction, which has now been superseded by a fourth cable. Three cables, therefore, had already been destroyed, partly by ships' anchors and partly by corrosion. Pure sea water, he believed, was not sufficient alone to produce this destructive action on iron, it was probably occasioned by copper, sulphuret of copper, iodine, or ozone held in solution. A cable buried in mud or sand was of course continually exposed to the action of the water, but as the same portion of water always remained in contact with the cable, he apprehended that it gave off at first its corrosive element to the iron, and became incapable of further mischief. This would account for the greater durability of cables under such circumstances. In 1859 he had attempted to imitate this action in a cable from Whitehaven to the Isle of Man, which he coated with asphalt, or rather with a serving of jute saturated with common asphalt; this process was inexpensive, and he thought the cable would last for a long period of time."

Mr. Fleeming Jenkin:—"On picking up the cable at the African shore, he found that the shore end was uninjured by corrosion, but as soon as the smaller portion of the cable was reached it broke in the same depth of water during the attempt to lift it. He then grappled, beyond, and at last came to the original fracture, which he believed to be caused by the trawls of the coral fishers, after the outer wires had been corroded. An extensive coral fishery existed on that part of the coast, and its grounds were crossed by the cable, showing the little care that was formerly taken in the selection of a route. Beyond this fracture the cable was discovered to be again broken at the distance of two miles. The whole of the small cable near Africa was corroded; it was covered with marine animals, and much coral was found deposited on it. The second fracture was due to corrosion, and to the coral fishers, as in the previous instance. Beyond that point the cable was so much corroded that it broke during the operation of lifting in 70 fathoms of water. The sea end, however, was found, and he ascertained from testing, that some of the wires were good up to about forty miles from Sardinia, but not the faintest signal was received. Sound cable was then laid to the African shore. He afterwards picked up the cable from the Sardinian end, and the first thirty-nine miles were as sound as when it was first laid down; in some specimens no rust whatever was apparent, and the section of the wire was not in the least degree altered. At this distance from the shore there was a change in the nature of the bottom, evidenced by the different colour of the mud, and the wires were much corroded. Shortly afterwards the cable broke in the depth of 1,200 fathoms, at a distance of one mile fram the spot where the electrical test showed that the cable had previously broken. Thus the previous fracture, which had stopped the working of the cable, had occurred at the above depth, as the cable lay apparently undisturbed, but with the wires greatly corroded. This did not amount to a positive proof, that in deep water a cable must necessarily break if the outer covering was corroded; but he thought it would be dangerous, after such a precedent, to lay down an unprotected iron-covered cable in deep water. With those forty miles of cable much coral and many marine animals were brought up, but it did not appear that their presence had injured the cable, for they were attached to the sound, as well as to the corroded, portions. Specimens of the rust from the cable had been submitted to analysis, which did not afford any evidence that the decomposition of the animal matter had led to the corrosion. There was corrosion near the African coast, but none near the Sardinian coast, although rocks and animals were found near both. The cable, where it was uncorroded, had not been buried in the mud, as was proved by the short, fine seaweed upon it."

Mr. Bidder:—"Corrosion could not be prevented, especially when the cable reposed on sand; but, commercially, that difficulty could be met by making a provision for renewal, at intervals, say of seven or eight years. So serious an element in the cost of submarine cables was their liability to corrosion, that, in the cables of the Electric Telegraph Company, the depreciation arising from this cause alone was estimated at £8,000 per annum.

(*To be continued.*)

ELECTRO-METALLURGY.

Law of Deposit and Practical Instructions.

In coating articles with metals, it is important that the power of the battery should bear a certain proportion to the strength of the depositing liquid. The intensity of the apparatus may be raised by having a greater number of pairs, by using a less diluted acid, and by warming the electrolyte; the quantity of the electric current may be increased by lowering the zinc plates in the liquid. The opposite effects can be produced by a reversal of these conditions.

The quantity of metal deposited depends on the amount of the electric current passing through the solution, and, consequently, upon the size and number of the zinc plates in each cell of the battery, whilst its quality is regulated by the amount of the current passing, compared with the size of the electrodes. The following may be given as the general laws of deposit, but different metals and different solutions vary so much that no positive relations can be fixed; only the general principles can be laid down. To obtain a bright crystalline deposit, a current of intensity and small amount is employed; for a hard and rather brittle reguline deposit, much force and moderate quantity; for a dark gritty powder, a strong and abundant stream; for an elastic and bright reguline precipitate, moderate intensity and small quantity; for a soft, tough, and perfectly reguline coating, a medium force and moderate quantity; for a soft dark powder, moderate intensity and large amount; for a soft sparkling film, low intensity and small quantity; for a tough reguline coating, low intensity and moderate quantity; and for an abundant soft black powder, low intensity and large quantity.

When the power of a battery decreases, a little acid may be added, and the liquid stirred; but the better way is to substitute fresh acid. The solution in the battery should never be allowed to become thick or to crystallize. If any of the silver or copper plates of a battery, or any part of them, become covered with zinc, it is a proof that the acid is becoming exhausted.

Gore ascertained, in a long series of experiments, that the depositing power was almost invariably increased by keeping the dissolving metal hot, and the receiving article cold, by means of an appropriate apparatus. He also found that the opposite effects were produced by a *contrary* arrangement of the temperature. To insure perfect circulation of the current, care must be taken that the circuit is complete, that it is capable of conducting freely throughout, and that the various wires are perfectly clean at all their points of contact.

It may be proper to repeat here, that in every case, to produce metallic deposition, there must be a complete circuit of substances: there must be a liquid in the circuit, the metal to be dissolved, and the article to be coated in that liquid, and to ascertain that this is complete, galvanometers are frequently used, particularly in cases of complicated apparatus.

Every large plating establishment has a number of stoneware pickling jars, pans, and vats of various sizes, called dipping jars, several large boilers of potassa liquid, various scratch brushes, both for hand and lathe, and several washing troughs with a plentiful supply of clean water.

Mr. Gore gives the following rules for successfully working depositing liquids:—

1. Avoid altering the composition or the proportion of the ingredients, except the water.
2. Adapt the electric power to the liquid, that is, regulate the precipitation by alterations in the battery, rather than by any in the depositing vessel, except that the distance between the cathode and the anode may be altered, generally with advantage.
3. The dissolving metal, as a general rule, should be larger than the receiving article, which will have a tendency to strengthen the solution in metal.

The most philosophical position for the negative plate is the horizontal, but in practice this does not succeed, because the metals used for dissolving are never pure, and their impurities fall on the surface of the article; moreover, the operator cannot examine or remove it. The most practical position is the vertical, the dissolving metal and the receiving article being suspended in the menstruum facing each other, the latter being rather the lower of the two, and both wholly immersed, and the liquid being occasionally stirred to keep it uniform.

If the article to be coated has a very irregular outline, it is necessary to beat the dissolving plate somewhat to its form, so that the two may be nearly equidistant in their opposite parts, and thus a regular metallic deposit obtained. The nearer the receiving object is to the dissolving plate, the more rapid is the precipitation; and a large body of liquid deposits more rapidly and evenly than a small one.

For forming the connections, copper in wires or ribands is the most suitable, and it is one of the best conductors and not expensive. Large connecting wires allow more copious precipitate than small ones. The article to be coated must be always connected with the zinc of the battery, and the metal to be dissolved with the copper or silver.

Precautions.—In some of the preceding operations, and especially in

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plating and gilding, the cyanide of potassium is employed. It is proper to state that this substance must be used with caution, both in handling the salt itself, and in breathing the cyanogen atmosphere which is exhaled from its solutions. When the operations are conducted in badly-ventilated apartments, the workmen are often affected with giddiness and other distressing symptoms; and their hands are liable to ulceration, particularly if they have been immersed in the solutions. By exercising proper care, and avoiding to inhale the vapour of the cyanides, these inconveniences may be averted; and the other ingredients used in the different processes are not attended with danger. On the contrary, Smee affirms, perhaps a little too strongly, that those conducting electro-metallurgical operations, generally fatten with their occupation, the minute quantities of sulphate of zinc and sulphuric acid which they imbibe, improving the tone of their stomach, helping digestion, and strengthening the whole frame. The salts of copper, he adds, have the same effects as those of zinc, but, perhaps, upon the whole, must not be made quite so free with. This is the testimony of a medical gentleman; but still, in these, as in all other chemical operations, it is prudent to exercise a reasonable care in avoiding to inhale too freely any of the gases given off.

Other Applications of Electro-Metallurgy.

It is manifest that the art of depositing metals from their solutions by galvanic agency, admits of a vast variety of applications. The more important of these have already been mentioned, but a few others will be briefly noticed.

Mr. Ritchie has patented a method for extracting copper from its ores by the following process:—The calcined ore is dissolved in dilute sulphuric acid; this solution is put into a large vessel or trough, and a mixture of two parts water, and one of a saturated solution of sulphate of iron is poured upon it, taking care not to mix it with the lower liquid. An iron plate, as a generating metal, is then placed in the iron solution, and a plate of lead in the copper solution to receive the deposit. The voltaic arrangement is completed without a battery, by simply connecting the two plates by a wire. This process has never been put into practical operation.

Napier patented a method of coppering cloth by the electro-process, which forms in that case an excellent fire-proof covering for roofs, railway waggons, &c.; but hitherto the article so manufactured has not succeeded in displacing the cheaper materials commonly employed for the same purpose. The cloth, being previously brushed over with a polish of black lead, and stretched upon a wooden frame surrounded with a copper band, is immersed in a large vat containing the cuperous solution. Battery power may then be applied, or a part of the vat may be partitioned off to receive the dilute acid and zinc. One pound of copper is found sufficient to communicate a perfect solid covering to twenty superficial feet of cloth.

Another method is to stretch the cloth upon a sheet of copper slightly curved, so that the cloth may be in close contact with it all over. The back or hollow side of the copper is then varnished, and a deposit formed by the battery process all over the front of the copper within the meshes of the cloth, and when sufficiently thick, the deposit and cloth firmly united together, may be drawn off the sheet of copper. Mr. J. Schottlaendder took out a patent, December 8, 1843, for depositing either plain or figured copper upon felted fabrics; he passes the cloth under a plain or engraved copper roller, black-leaded and horizontally immersed in a sulphate of copper solution; the copper is deposited upon the roller as it slowly revolves, and thus the meshes of the cloth are filled with metal, and the design of the roller copied upon it, and the coppered cloth slowly rolled off.

Cells for Daniell's battery may be made by electro-deposition. For this purpose, coat the inside of a jelly-pot uniformly all over with wax or stearine, and then either brush it over with plumbago, or treat it with phosphorus, silver, and gold solution; a connection should then be formed with the lower part of the coating, and the deposit effected either by the simple cell process, using the jelly-pot as the outer containing vessel, or by the battery process, using, in either case, a sulphate of copper solution.

Hard copper dies may be formed from impressions on sealing-wax, gutta percha, or any other substance used for moulds. All embossed surfaces may be copied with facility, whether they consist of paper or any other material. If porous, they must be first rendered non-absorbent by oil, varnish, or wax, according to the thickness of the texture. Black-lead may be used to impart a conducting surface to seeds and roots, or other solid productions. But delicate leaves or flowers are prepared to receive the deposit by immersion in Mr. Parkes' solution, already described. Electro-coppered leaves, branches, and similar natural objects, are very beautiful. Even the delicate tendrils and hairs of plants may be all perfectly covered by this process. Insects may be coated or copied in the same manner. Every vegetal and animal substance whatever, which will remain undecomposed in the solution of copper for a few hours, can have a metallic mould made from it, or a metallic coating thrown over it.

But one of the most promising applications of the art is to the purpose of engraving and printing. This was the only application, indeed, which first occurred to its inventors, Jacobi, Jordan, and Spencer; and the art was pursued for some time with no other useful object in view. Hence its original name, the electrotype, which, although perfectly applicable when it was confined to the copying to objects, such as copper-plates, types, and medals, has long ceased to be appropriate, and does not embrace, in its etymological meaning, the far more important branch of the art, which consists in imparting to objects of use, or ornament, a permanent covering of gold, silver, copper, or some other metallic deposit. The word electrotype, in short, which, in accordance with its Greek origin, expresses the copying, moulding, or modelling of figures, or characters, by electricity, embraces only a part of the art, which, in its numerous modern applications, is more appropriately termed electro-metallurgy. This is the generic name for the whole. Electro-typing and electro-plating—using the latter term, as it ought to be used, with reference to all the metals, and not to silver alone—constitute its two leading divisions. There are, however, certain processes, such as the reduction of metals from their ores by voltaic agency, which, although correctly expressed by the general name, are contained within neither of these divisions.

One of the first objects pursued by Spencer was to produce copies or facsimiles of common type, by the electro-process. This attempt was attended with very indifferent success; but, of late, a patent has been taken for a method of preparing stereotype plates, which promises to be of great value. This operation is performed on plates of the common stereotype metal, and consists in depositing a film of hard copper on the face of the letters. By this process, the plates are rendered much more durable, and yield a greater number of impressions without injury. A copper facing is given in the same manner to common type.

There is nothing to prevent forming the stereotype plate itself of deposited copper. A mould may be taken in the common way, either in paper or plaster of Paris, and this being saturated with oil or wax, and carefully covered with a film of black lead, or dipped into Parkes' patent solution, might receive a copper deposit of any thickness. The deposit being taken from the mould, and filled in with plaster of Paris, or gutta percha at the back, could be fixed to a block of wood or stereotype metal; but, probably, the trouble attending these operations would scarcely be compensated by any advantages gained. Instead of the paper or plaster, gutta percha, softened in boiling water, would form an excellent material for the mould, and would not require the preparation with oil or wax. De La Rue has been very successful in applying the electrotype process to many operations in ordinary printing. It has also been applied to plates for printing music, and for embossing soft materials, such as leather.

The multiplication of plain copper-plates, by this process, may seem to be a somewhat circuitous method of doing what is more easily effected by simple rolling and hammering. Yet, to make good copper-plates for engraving, is an operation attended with some difficulty; and those little cavities in the metal, which are found even in the best commercial copper, produce a degree of uncertainty in the engraving. These are avoided, and the process is much simplified, by depositing an electro-type plate on one of the prepared copper-plates. Deposited metal is always perfectly pure, and, by adjusting the power of the battery to the strength of the solution, may be made of any required solidity.

But a higher application of the art is to copy engraved copper-plates, which may be done with great nicety, producing a perfect fac-simile of the original. It matters not how complex the design, or how fine and delicate the execution—the engraved plate may be copied with the same ease and fidelity as the plain plate. The electrotype resembles the daguerreotye in showing its powers to the greatest advantage when it is employed in reproducing the most elaborate tracery. In applying the process, however, to engraved plates, on which the design is always in intaglio, the first electrotype plate that is deposited will be in relief. This plate must, therefore, be used as a mould for depositing upon it a second plate, which will be a fac-simile of the original. Another plan of forming the mould is to take an impression from the engraved plate, on a perfectly clean surface of lead, by means of a copper-plate press. To avoid the curling of the plate by the pressure, Smee recommends that, when it is placed upon the lead, another plate be placed above it, before passing through the press. But very good moulds may be formed in white wax, or plaster of Paris, and, probably, still better, and more conveniently, in gutta percha.

The Art Union of London has employed this process to multiply copies of original plates, and it was found that the impressions taken from each electrotype varied from four hundred to one thousand, depending chiefly on the character of the engraving. The multiplication of engraved plates, in the same manner, is usefully carried out at the Ordnance Map Department, at Southampton. Each copper-plate map, when finished by mechanical engraving, is transferred to the electrotype department, where any required number of duplicate plates are taken. Electro-metallurgy has, in this case, been of the utmost importance by enabling the Ordnance maps to be published at a moderate price.

The great demand for engraved copper-plates is at the potteries and calico-printing establishments. For use at the potteries, the device must be deeply cut in the copper, from which it is printed on a piece of thin paper, with a composition of arsenite of cobalt instead of the ordinary printer's ink. The paper is then pressed upon the pottery plate before it is glazed, in order that the ink may adhere to it, after which, the paper is washed off. Both the potters and the calico-printers chiefly employ the engraved plates in the form of cylindrical rollers—the plates, when engraved, being bent round in a cylindrical shape, and the edges soldered together. These copper-plates, before they are bent, may be easily multiplied by the electrotype process; but although active attempts were made so early as 1841, to apply the electro-deposition of copper to the preparation of the rollers in the first instance, both by depositing the copper

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upon wax, or other moulds, to make an entire roller of copper, or by depositing a surface of copper on iron or brass, the practical difficulties met with, in trying these applications, have hitherto been found insurmountable.

Woodcuts are easily multiplied by giving them a coating of black lead, and applying the ordinary process, first to produce a mould, and then a fac-simile in copper. Or a gutta percha impression may be employed with advantage for the mould in this, as in many other cases, for which its use is invaluable. But duplicates of woodcuts are so readily taken by the common stereotype process that this will continue to be generally preferred for common work. At the same time, for good engravings, the electrotype process is preferable. One of the most beautiful series of specimens of printing from electrotypes is to be found in an illustrated edition of *Thomson's Seasons*, all the woodcuts of which were carefully preserved, and the actual printing performed from electrotype copies.—*Dr. Muspratt's Chemistry.*

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

Para, fine	1s. 11d. to 2s. per lb.
Negro Head	1s. 1d. to 1s. 3d. „
Java	1s. 5d. „

A Parcel of very ordinary Penang Four Class Sea, damaged, has been sold at 10d. per lb.

GUTTA PERCHA.

Fine	2s. 6d. per lb.
Genuine mixed	1s. 10d. to 2s. 2d. „
Ordinary reboiled	9d. to 10d. „

August 14, 1862. WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	50 to 55	——
20	Do. B 7 per cent. till 1862 .	all	19 to 21	——
20	Do. C. „ „	all	——	——
10	London & S. of Ireland Direct.	2	— pm.	——
Stock	Electric Telegraph . .	100	102 to 105	——
25	Ditto, New	20	——	——
5	London District Telegraph .	$4\frac{3}{4}$	$4\frac{1}{4}$ to $3\frac{3}{4}$ dis.	——
10	Mediterranean Extension Tel.	all	4 to 5	——
10	Ditto. 8 per cent. pref. . .	all	——	——
20	Red Sea and India Telegraph	all	——	——
1	Submarine Telegraph, scrip.	all	$\frac{3}{8}$ to $\frac{5}{8}$	——
1	Do. registered . . .	all	$\frac{3}{8}$ to $\frac{5}{8}$	——
10	Do. „ . . .	all	4 to 6	——
2	Telegraph to India . .	1	$\frac{5}{8}$ to $\frac{3}{8}$ dis.	——
5	United Kingdom Telegraph .	3	$\frac{1}{4}$ dis. to $\frac{1}{4}$ pm.	——

Telegraphic News.

DIRECTORS' REPORT OF THE LONDON DISTRICT TELEGRAPH COMPANY (LIMITED).

IN presenting the accompanying statement, the Directors feel that they may congratulate the Shareholders on the improved position of the Company. The increase in the receipts has been gradual throughout the half-year, and, although the general effect of the International Exhibition may to some extent have latterly contributed to this result, the fortnightly returns show that a steady average increase has pervaded the period.

	£	s.	d.		£	s.	d.
Fortnight, ending January 9 ...	222	6	8	Fortnight, ending April 17 ...	286	18	2
„ „ „ 23 ...	244	5	1	„ „ May 1 ...	275	1	3
„ „ February 6 ...	261	17	3	„ „ „ 15 ...	320	12	7
„ „ „ 20 ...	255	16	6	„ „ „ 29 ...	316	8	8
„ „ March 6 ...	252	4	4	„ „ June 12 ...	346	13	11
„ „ „ 20 ...	275	0	7	„ „ „ 26 ...	341	1	4
„ „ April 3 ...	278	15	2				

The following Summary of Receipts and Number of Messages will show the progress of the traffic since the commencement of the undertaking:—

Half-year, ending.	Gross. £	s.	d.	Net. £	s.	d.	No. of Messages.
June, 1860	751	11	0	550	19	11	23,115
December, 1860...	1,547	12	9	1,058	19	2	47,365
June, 1861	3,232	11	4	2,137	1	7	64,785
December, 1861...	4,147	1	4	2,592	15	10	77,939
June, 1862	6,513	18	4	3,956	4	8	123,280

A comparatively small outlay on Capital Account has been made during the half-year, chiefly for the purpose of providing private telegraphs where spare wires were already available, or for opening new offices in important thoroughfares and districts near which the wires already passed.

The general current expenditure has been kept as low as possible consistently with the efficient working of the large and increased business. The charge for "repairs and maintenance" is necessarily to some extent beyond control, and fluctuating. Thus, for instance, during the half year, in consequence of several violent gales, considerable outlay was incurred for repairs to roofs of houses on which the poles are fixed.

The Solicitors having reported that the Calls on forty-five Shares are irrecoverable, the Directors propose to forfeit them.

The whole of the property has been maintained in good working order.

It will be seen that the Directors have not availed themselves of the borrowing powers authorized at the last Half-yearly Meeting.

The seat in the Direction caused by the retirement of Mr. J. W. Brett not having been filled up, the Directors have the satisfaction of stating that Sir Charles Bright has consented to occupy it. A vacancy has also occurred by the retirement of Mr. Alderman Rose, but the Directors do not recommend that it should be filled up at present.

The Directors are still confident as to the ultimate prospects of the undertaking, which time will materially assist to develop, and this opinion is strengthened by the steady increase shown by the above statements.

[Owing to the want of space, the balance sheet is deferred to next week. —ED. E.]

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

CLASS XIII AT THE INTERNATIONAL EXHIBITION.

To the Editor of THE ELECTRICIAN.

SIR,—An eccentric friend of mine, from the country, who dropped in upon me one morning before breakfast, some six or seven days since, left me this day in the same abrupt and unaccountable manner: among a mass of papers left behind, I find the enclosed, which I send to you by way of revenge for his want of courtesy.—I am, yours respectfully,

MOMUS.

There is a massive building in the west,
  Where you, and I, and all the world have been,
Or, if you have not, follow my behest,
  And go at once, while yet the thing is green:
For me to picture it would not be best,
  Besides I want to speak of Class Thirteen,
A subject rich and fruitful, and withal,
Concerns my present readers, great and small.

In this said Class, august philosophy
  Enthroned sits, and to the vulgar crowd
Diplays her wonders, without extra fee.
  On this hand you may see a thunder cloud
Turned inside out, on that, photography,
  (To which the highest heavens have humbly bowed),
Shows you the back door of the gentle moon,
Through which the hero passed who rose too soon.

Here gentle lady you may have your breath
  (Your respiration I should say) depicted,
An aromatic sight! And if to death
  You haste by stealthy pulmonem afflicted,
Here's a fine instrument that chronicleth
  The process of decay; and here restricted
To humbler things, but useful I dare say
Is a machine for milk, and curds and whey.

This tells you what o' clock it is at noon,
  That tells you where your ship is when at sea,
This lights the same regardless of the moon;
  And if the weather's hazy where you be,
Here's an horizon made to order soon;
  And this records the sunshine faithfully:
This telescope will show you Saturn's rings
And this reveals much less than little things;

With differential double stethoscope,
  Sextants and stethogiometer,
Galvano-piline, weights, nepheloscope,
  Hydrometer and saccharometer,
Polariscope, debuscope, mimoscope,
  Clinometer, marine barometer,
Dioptric lights and hydrostatic scales,
Pneumatic pumps, and pentagraphic nails.

Faith these are wondrous things, and clever men
  They are who understand them, some do say
Such men know all things, from the deepest den
  Of Pluto's realms up to the milky way;
And I should like to know such men, for then
  I would not sit and scribble here all day,
But with a firm and resolute endeavour,
Rifle Dame Nature's pouch and live for ever.

But there are other things in Class Thirteen,
  (As well as these), that had no business there,
At least some people say so, but I ween,
  What e'er they say, Commissioners don't care,
And confidentially ourselves between,
  To grunt and grumble is to beat the air;
But never mind, a few facts now are ripe
For all the "pomp and circumstance of type."

O Fellows of Society most Royal,
  'Twas thought you were the very men to grapple
With these hard things, for wise are ye and loyal;
  'Tis said ye know the colour of the apple
Which our first mother ate, and cost our joy all;
  Also Pandora's box, and whether dapple
Its hue, or red or green or black or white,
And catalogued its contents in a night.

This may be true, and far be it from me
  To think that less, which I would fain have more;

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But had ye known all, then telegraphy
Included would have been, and at your door
Unfairness, non-impartiality,
Would not have lain, and men felt precious sore,
Because three other jurors by the nose,
Whilholm did lead you wheresoe'er they chose.

Ah friends electrical and telegraphic,
Ye were not wholly taken by surprise,
Your joy could scarcely have been quite seraphic,
When first the list of jurors met your eyes:
For, to use language apropos and graphic,
Men do not look for mushrooms in the skies.
You are indignant, and I share with you
Your indignation, without more ado.

We'll put the facts in everlasting print,
And treat them with imperishable scorn,
And future generations thus by dint
Of our veracious records, shall, inborn,
Cherish the withering feeling, without stint.
Nor shall the night precede the morning's dawn,
Nor distant centuries tread upon the age,
That blots the record from th' historic page.

Here is Tomfilius, D. and double L.,
Here also is Cornlapis F.R.S.,
And Jenkins, but as yet without a tail,
The stump, however, is not promiseless,
(A tail in embryo should be watered well);
These be your jurors, neither more nor less
Than three wise men, and one of them you see
An expert is, whatever that may be.

Professor T. 'twas very good of thee,
Thy own most worthy self not to forget,
E'en through thy snowy friend, for probably
Thou and good fortune might not so have met
Again, and 'tis agreeable to see
A man that knows the fickle dame, and yet
Can twit her, spurn her; tell her "here's my friend,
Deal lavishly, and adverse gifts forfend."

And thou, Cornlapis, shouldst have shunned the trust,
However flattering to thy lofty mind,
For it were more than human to be just,
When prejudice and passion help to blind
The judgment with self-interested dust,
And righteous equity is left behind:
A giant should not clip his eagle wings,
And dwarf himself to Lilliputian things.

Oh had these three unto themselves been true
And to telegraphy, they would have spurned
The odium which incompetency drew
Upon the noble science, and have burned
With indignation, when they knew
Her glories in oblivion were urned.

They were her own high priests, and their vocation
Comported not with her humiliation.

The sorrowing muse would then have had no need,
From her transcendent eminence to swoop
On things which the award of censure need,
Nor yet to blush, and hide her head, and droop
Her flutt'ring pinions, and on ashes feed,
Nor earthward ignominious stoop
Her glitt'ring crest; but would have sought the skies,
And revelled in her native melodies.

Alas! that any shaking shivering sprite
Should have to sing of things so mean and sordid,
As a magnetic clock that won't keep right,
Yet for its strange veracity rewarded;
While this, by which is checked the God of light,
And all his eccentricities recorded,
Unnoticed is: perhaps 'tis sacrilege
To tread so closely on Sols' heritage.

Triumphant proofs of telegraphic skill,
Ye mighty stepping-stones that mark the strides,
The giant strides of genius up the hill
Of science: clamber still the rugged sides,
Regardless of the enmities which fill
Officious and depreciating pride:
Progressions' sons need not their patronage,
Mankind shall honour them from age to age.

Ye devotees of scientific might
And lofty mechanism, combine your powers
As heretofore, for a still higher flight
In that most noble enterprize, which towers
Superior to the ordinary height
Of man's philanthropy. In perilous hours,
When myriad lives hang on a point of time,
But saved by science, 'tis "a feat sublime."

And ye who wish to compass this our earth,
Sheer through the surging sea, and o'er the land,
With a metallic insulated girth;
That pole may speak to pole, and Sarmacand
With Spain, and this blest island of our birth,
The centre of the radiating band,
Vibrating freedom, peace, and amity,
To every island in the boundless sea:

Take heart, pursue unto successful ends
Your skill, your wisdom and your industry,
Careless of that incompetence that lends
The tenure of its brief authority
To paltry favouritism: the ripe earth tends
To new developments: the pedantry
Of self-sufficient pigmies it abhors:
And asks for veterans in progression's cause.

To the Editor of The Electrician.

Sir,—It is with great pleasure that I take the opportunity to offer you my sincere thanks for the article on "Railway Telegraphs," by Mr. W. H. Preece, commenced in your last number. I think the subject will be interesting to all your readers, particularly those connected with railways, but I am afraid there are very few railway managers or railway superintendents that are subscribers to The Electrician, in fact I know one or two railway telegraph superintendents who do not take, or even get to see The Electrician, and if railway directors will appoint such men for so important a position, they will doubtless some day find out the error.

I have ordered a few extra numbers of The Electrician, which I hope to distribute amongst friends, and if your correspondent "Inquisitive" be charitably inclined, I would recommend him to distribute a few numbers amongst railway officials, then perhaps he might obtain "a little of their practical experience upon the subject."—I am, sir, yours truly,

August 12th, 1862. B. C.

THE MALTA AND ALEXANDRIA CABLE.

To the Editor of The Electrician.

Sir,—I have not been able to ascertain whether the "further" coorrespondence, &c., respecting the above extraordinary disposition of public property is to be furnished or not? Perhaps some of your readers may be in a position to enlighten me upon the subject.—Yours, &c.

One of the Public.

CORROSION OF IRON COVERED CABLES.

To the Editor of The Electrician.

Sir,—Your remarks upon the above subject, in your last number but one, are deserving of the most serious consideration. Ample warning has been given of the inevitable result of covering our insulating cores with naked iron wires. Yet the Malta and Alexandria cable, and others, constructed at the public expense, is sheathed with naked iron, and for no other earthly reason than to keep the machinery of iron rope manufacturers employed; in whose hands telegraphy has become a reproach to English ingenuity and enterprise. I also wish to point out that our would-be leading electricians are instrument makers, this should not be so.—

Yours, &c., J. Farnborough.

Edinburgh.

Miscellanea.

One of the "cuts" in our last impression—not a very delicate production of the engraver's art, but sufficient for our purpose—was executed by a very simple process, to which we devoted one half-hour of our own time. A plate of copper was coated with melted wax, through which, when solidified, we cut the lines of the drawing down to the metal. The lines were then lightly touched with a camel's hair pencil moistened with sweet oil. Next, the lines were "raised" by covering the untouched portions of the plate with a composition of melted wax and oil applied with a brush. The surface was then coated with plumbago and polished. A copper deposit, by means of the battery, completed the operation, and furnished the specimen in question.

To Correspondents.

Haverfordwest.—The observation of Nicholson, referred to in an article by Sir W. Snow Harris, quoted in our last number, viz., that "although in moderate charges the exploding distance appears exactly, or very nearly, proportionate to the charge itself, yet, for very high intensity, the distance to which the charge is carried exceeds that proportion," has some relation to the question you have taken up. Very peculiar conditions appear, however, to be involved in the phenomena of atmospheric electricity. Let us suppose that your electrical conductor, giving a spark one inch in length, was composed of a dense volume of watery vapour. This, when condensed into watery globules, would virtually set free the accumulated electricity, which, like the lightning flash, might, from almost any distance, shape its course to earth. You probably underrate the attractive force of a thunder-cloud, which, acting upon a vast extent of ocean, and overcoming, to some extent, the force of gravitation, and producing also atmospheric currents of great power, contributes to that magnificent perturbation of Nature which is shown in a storm at sea. We cannot be surprised that bodies at the surface of the earth or ocean are not under ordinary conditions actually carried away by the action of the clouds' attractive power; for, in addition to the effect of gravitation, such bodies, already polarized to some extent, would be further polarized if removed from conducting communication with earth, and would thus be electrically attracted in opposite directions. The influence of vegetation in withdrawing electricity from the lower strata of the atmosphere is a generally recognized fact.

J. Cook.—If the sliding weight which you would attach to your oscillating lever be "almost sufficient" to counteract the attractive force of the permanent magnet when its armature is in contact, it will be *quite sufficient* to counteract this force when the armature is separated; and the lever will remain at rest with one of its extremities in contact with the temporary magnet. Is it not so?

Archimedes.—We appreciate the improvements in the divided ring commutator. If not carefully carried out, however, the spring might be liable to catch and be broken, owing to the metal not being quite flush with the wood. We can only undertake to give a few general hints upon the construction of the magneto-electric machine; the questions respecting which are somewhat indefinite. As usually made, the distance between the poles of the armature, or soft iron core, is at least equal to the height of the magnet; so that when the core is transverse to the poles of the latter, the inductive effect is practically *nil*. Your magnet would appear to be of less breadth than height, with a space of only ¼ in. between the poles; and the coil, when placed transversely to the line uniting these poles, would, therefore, be under an inductive influence exerted at right angles to the normal direction of polarisation. This "cross polarisation," however, would probably not interfere to any considerable extent with the results to be obtained, but is a point which, nevertheless, is deserving of some consideration and study. The soft iron core (cylindrical) might be 1¾ in. diameter, each arm 3½ in. in length, space between the poles ¼ in. The magnet would then be of somewhat unnecessarily large dimensions, as regards height. For the quantity armature, we may suggest a length of 40 to 60 yards, No. 7 guage wire; for intensity effects from 1,000 to 2,000 yards, No. 32 guage wire, the latter very carefully insulated with silk.

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The Electrician.

VOL. II. No. 42.—AUGUST 22, 1862.

CONTENTS:

	PAGE
Ohm's Laws	181
On the Comparative Periods of Charge of Various Lengths of Submarine Cable	182
Some Considerations on the Principles of Electrical Conduction and Accumulation	182
On the Periods Occupied in Charging Different Lengths of Telegraph Wire, &c.	183
Iron Covered Cables	185
International Exhibition	185
Applied Chemistry	186
Physical Science	186
Prices Current of Insulating Materials	187
Telegraph Shares	187
The Progress of Telegraphy	187
Electrical Illumination for Lighthouses	188
Telegraphic News	188
Correspondence	190
Miscellanea	192
To Correspondents	192

OHM'S LAWS.

THE time is past when mathematicians could venture to impugn the accuracy of the fundamental laws of dynamic electrical force, propounded and established by Professor OHM. Based upon careful and extended experiment, as well as upon the most refined mathematical demonstrations, they can only be more strongly confirmed by any critical investigation which may be bestowed upon them by those who, in most cases, must necessarily follow upon the same grounds of inductive research. The apparent *reductio ad absurdum* of the physicist, also, is found in most cases to disregard some very obvious postulate required by the conditions under which the law of OHM is applicable; and it happens that where the conclusions arrived at under this law are not susceptible of experimental verification, they cannot, on the other hand, be disproved, either by experiment, or upon any grounds of reasoning which can be preferred to those upon which the law in question is based. It may surprise some of our readers that any of those who are familiar with the general problems of voltaic science, and who have given their attention to the laws of OHM, should be inclined to question the latter in any particular. It should be remembered, however, that many have entered upon the study of electricity as a branch of physical science in intimate relation with chemistry, and that many of the conclusions of OHM appear, on *primâ facie* consideration, to be in opposition both to physical and chemical axioms. Others, on the other hand, have regarded electricity as a branch of applied mathematical science, and have studied it almost exclusively in this light. There are not a few who, failing to obtain from physical or chemical science any definite and settled notions on the subject of voltaic electricity, have gladly made the formulæ of OHM the foundation of their electrical knowledge, and the starting point of all investigation. The latter may often be inclined to deduce their electrical theory from these *formulæ* rather than to arrive at a correct appreciation of the latter, by endeavouring to trace the operation of natural laws originating electrical effects, a method which was probably not contemplated by the distinguished philosopher who based the expressions upon a more or less extended observation of nature.

While we admit that the *formulæ* of OHM, so far as they extend, are in exact accordance with our general experience of voltaic action, we may safely allow that they may, to some extent, be based upon a purely artificial foundation. In this we by no means detract from their practical utility. Until, for the first time, they lead to a conclusion which is seen to be erroneous in practice, we may benefit by their conciseness and general applicability. Until they can be disproved in any essential point of theory, we must also admit, upon at least equal grounds, their claim to theoretical accuracy. But, while we hold that, so far as they express facts with which they have been, and are, constantly found to be in perfect accordance, the laws of OHM are established beyond question, we can readily conceive that they may possibly be found susceptible of improvement so far as they express general conceptions of physical agency.

It is said that, when a certain electrical engineer was called upon to write, in a concise form, a treatise, embodying the most useful facts in the application of electricity, he complied with the request by reproducing the following:—

$$I = \frac{n\,E}{\frac{n\,R\,D}{S} + \frac{r\,l}{S}}$$

In this brief expression are condensed all the main facts relating to the operation of dynamic electricity. Without pretending to know the nature of E and R r—viz.: the electromotive force, and the condition of matter which opposes its manifestation, and without attributing to either anything beyond their observed effects, OHM has here represented in the abstract, with mathematical accuracy, the relation of the active and counteracting forces by which the value of I—the quantity of electricity passing in a closed circuit, is determined. Giving to n, D, S, and l, certain fixed values, we can thus readily ascertain in what degree I is affected by any alteration in these elements. For the benefit of those who may not be familiar with the *formula*, we may explain that I signifies the "intensity" of a voltaic current, or the quantity of electricity traversing the circuit; n E, the number of electromotive forces, or of voltaic couples, of similar nature, united for tension; n R, the number of fluid resistances in the battery, equal to the number of cells employed; D, the distance between the plates; S, the section of fluid between the plates; r, the external wire resistance; l, the length of wire; and S, its section.

Taking the simpler formula—

$$I = \frac{E}{R + r}$$

in which $R = \frac{D}{S}$, and $r = \frac{l}{S}$; and which expresses the fact that the strength of the current varies directly as the electromotive force, and inversely as the sum of the resistances, we may examine one or two of the cases to which it has been often assumed that OHM's law is inapplicable. Let us take a voltaic couple of moderate dimensions, and complete the circuit by a short length of stout copper wire, say 1 yard No. 7 bell-wire. After observing the effect upon a suspended magnetic needle, or "quantity galvanometer," let the circuit now be completed with half this length of wire. Although it is evident that the external resistance r has been halved, the strength of the current as shown by the galvanometric indication will not be sensibly affected. This apparent anomaly is readily explained when we give to the formula a concrete form applicable to the case in point. Thus if we have—

$$I = \frac{E}{50 + 2}$$

the value of I will be decreased by $\frac{1}{52}$ only, by halving the external resistance represented by 2.

Again, let us now complete the circuit of the single cell with a long length of fine wire, say 1000 yards, No. 40. According to a view which was once very prevalent, the wire will, under these circumstances, convey the maximum quantity of electricity, at the given tension, that it is susceptible of conducting. In other words, if we double the area of the battery plates without increasing the distance between them, or, what is the same thing, if we unite two similar cells for quantity, we should not increase the indication upon a galvanometer. Neither in practice will we do so to any appreciable extent. In this case the formula might be—

$$I = \frac{E}{50 + 10{,}000}$$

and by halving R, represented by 50, we can increase the value of I but to a very minute degree. It will be seen, therefore, that the expression of OHM is applicable to both the cases we have mentioned.

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In the following experiments the nature of the battery resistance, $R = \frac{D}{S}$, appears to be called into question. Let us take a plate of zinc, one of copper, and one of cast iron, of equal size. Immerse the zinc and copper elements in a saturated solution of salt, acidulated with sulphuric acid. Complete the circuit with a *short thick* wire, and a quantity galvanometer. The indication may be, say 40°. Now replace the copper element by the cast-iron, preserving constant the distance between the plates; the galvanometer will be deflected to a far greater extent, say to 70°. We have, however, neither altered r, nor R so far as the latter depends upon $\frac{D}{S}$. But R, according to Ohm's general formula, must obviously be greatly diminished by the substitution of the iron for the copper; and the expression $R = \frac{D}{S}$ cannot, therefore, be applicable in a general sense. It is to be observed that Ohm does not apply it in a general sense, but, the elements being given, to any particular case. Taking either couple—zinc-copper, or zinc-iron—the *formula* will be found in accordance with the experimental results in each case respectively, though inapplicable to these and other cases collectively.

When dilute sulphuric acid, instead of pure water, is used in a battery couple of zinc and copper elements, the action, as is well known, is increased, more especially when the external resistance is but small. The chemist would in most cases be inclined to attribute this effect to the increased chemical action. According to the mathematical theory, the increased chemical action is merely consequent upon the diminished resistance; the latter being the true cause of the augmentation in the quantity of electricity traversing the circuit. The great mass of evidence is, undoubtedly, in favour of the last-mentioned view; but the following experiment, designed to support the contrary hypothesis, is worthy of some consideration, as it has not yet been satisfactorily explained upon the grounds taken by Professor Ohm. Three flat porous vessels of earthenware were arranged in a glazed vessel of sufficient capacity just to contain them. The porous vessels were then filled respectively with the following fluids in the order given, viz.:—

Solution of sulphate of copper. Dilute sulphuric acid. Water.

The space between the porous vessels and the outer jar was then filled up with water; a plate of copper was immersed in the copper solution, and a plate of amalgamated zinc in the water of the third porous vessel. The circuit being completed, and the effect upon a galvanometer noted, the porous jars were then arranged as follows:—

Solution of sulphuric copper. Water. Dilute sulphuric acid.

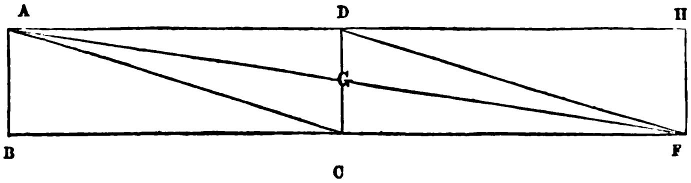
The copper element, as in the former case, was immersed in the copper solution; but the zinc was now placed in the dilute acid. In every case an increased deflection was in this case observed; the external resistance remaining constant. The interior resistance of the battery was, therefore, affected, although the distance between the plates, and the section of fluid between them, were in both cases the same.

ON THE COMPARATIVE PERIODS OF CHARGE OF VARIOUS LENGTHS OF SUBMARINE CABLE.

[Concluded from page 169.]

We this week give insertion to a communication which, by many, will be accepted as completely setting at rest the vexed question of the resistance to charge in similar wires of unequal lengths. The ratio obtained is not what the author at one time anticipated, nor is it in accordance with our own conclusions, being that of the squares of the lengths exactly, which, we contend, is inaccurate. We promised in our last number to bring this subject, so far as the expression of our own opinions is concerned, to an immediate conclusion; and we shall, therefore, now confine ourselves to giving a simple illustration in support of our view that the comparative periods of charge of different lengths of wire cannot in any case obtain the ratio of the squares of these lengths, however this ratio may be approximated to. If the conclusion we arrive at from the following considerations can be disproved, we need scarcely say that we shall be ready to modify our views in accordance with the theory which has generally prevailed.

Taking a single and a double length of wire represented by B C and B F in the following figure, we have it admitted that the time of charging, when the wires are insulated from earth, will be in the ratio of the squares of the lengths. To communicate the charge represented by the rectangle A B F H, four times the period of time necessary to communicate the charge A B C D will be required. Now, it follows that if we could communicate to B C a charge represented by the triangle A B C, and to C F a charge represented by D C F, we should preserve the same ratio in the periods of charge, the equal rectangles being halved and the distribution of the charge in each section of wire being unaltered.



If we can charge the length B C, when connected to earth at C, in one unit of time, we may conclude, therefore, that four units of time would be occupied in obtaining upon the double length, B F, a distribution of electricity represented by the triangles A B C and D C F. This distribution would give, for the periods of charge, the ratio of the squares of the lengths of wire. Taking, however, the diagonal A F to represent the distribution of the charge in the double length, the distribution is materially altered. To the triangle A B C, representing the charge of the section B C, we have added the triangle A C G, representing a further quantity of electricity accumulated upon this section. From the triangle D C F, representing the charge we have assumed for the section C F, we subtract the triangle D G F, representing a portion of this charge. It is obvious that if the periods occupied in the distribution of the quantities indicated by the two triangles, A C G and D G F, are equal, we have no alteration in the original ratio for the periods of charge. But, if these periods are not exact equivalents, this ratio is materially altered under the conditions which prevail in practice. It requires but little consideration to perceive that a less time would be required for the distribution upon B C, of the quantity, of electricity represented by A C G, than for the distribution upon C F, of an equal quantity, represented by the triangle D G F. In this case the law of the "squares of the lengths" cannot consequently be applicable; and as we have indicated, the ratio of the periods of charge for single and double lengths will be less than that in question.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 171].

Electrometers properly arranged give us, therefore, information of the proportionate quantity of electricity actually communicated to that part of them designed to become charged, and exert a measurable repulsive force. But this is all the direct information the very best instrument can give; and in deducing from this information the comparative electrical state of any other conductor connected to them we must carefully take into considera-

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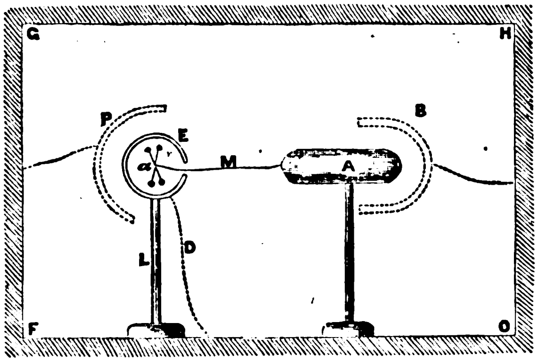
tion all the circumstances of the case. For when that part of an electrometer designed to become charged is connected to a charged conductor, it simply forms with that body and the connections a single charged body. The distribution of the total quantity on the whole system will, therefore, take place according to the conditions for accumulation at the different parts; or, in fact, according to the inductive resistance separating the charged surface, in different directions, from the opposing surrounding surfaces on which the equal and opposite state exists.

The quantity passing to the electrometer, even from a *given conductor* charged with a *given quantity*, may, therefore, vary in two successive experiments The quantity passing to the electrometer gives us, therefore, no definite idea of the proportionate quantity on a given conductor to which we connect it, unless the conditions for accumulation, both on the electrometer arms and on the conductor, remain constantly unaltered in successive experiments.

Fig. 90.



To illustrate this let *a* (fig. 90) represent the arms of an electrometer, or that interior portion intended to become charged and act repulsively; and let E represent the metallic outer armature, surrounding *a*, which I have shown is indispensable to definite results; and let the whole instrument be insulated by a glass support L. Let, now, the interior portion, *a*, be connected to a positively charged and insulated conductor A. Then a redistribution of the charge on A will take place, a portion passing to the electrometer arm *a*; an equal alteration in the negative state on the surrounding surface, F C H O, taking place. The armature, E, will be polarised in its thickness; its interior will be negative, and its exterior positive. The electrometer arms having, therefore, a certain charge, will, consequently, indicate this by a certain repulsive force.

If, now, the surrounding objects be approached to the conductor A, as, for instance, if a hollow conductor, B, connected to the surrounding objects be approached round A, the inductive resistance will be decreased on those portions of the conductor A, surrounded by the uninsulated conductor, B, and consequently a redistribution will take place. Some of the charge on the arms of the electrometer, *a*, will, therefore, pass back to the conductor A, a corresponding distribution taking place in the opposite charge on the surrounding objects; at the same time that the polarized state of the electrometer armature, E, will be decreased by the decrease of the quantity on *a*, and its opposite state on the surrounding surfaces, by which quantities the polarization of E was brought about. The electrometer will, therefore, show a smaller charge.

If, now, the surrounding objects be approached towards the electrometer, as, for instance, if an uninsulated body, P, be brought near to the armature, E, then the inductive resistance being decreased between *a* and the surrounding surfaces, a redistribution will again take place, and a flow will take place from the body, A, to the electrometer. If, now, the armature, E, be connected to the surrounding objects by a connecting wire, D, then the armature, E, will simply form part of the surfaces, surrounding the positively charged bodies, on which the negative state exists. The inductive resistance between the electrometer arms *a* and the oppositely charged surrounding surface is, therefore, reduced now to the resistance between *a* and the interior of the armature, and is, therefore, now at its minimum. A further flow from A to the electrometer will, therefore, take place. If, now, uninsulated bodies are approached to the armature, E, not the slightest effect on the distribution, and, consequently, on the instrument, will be produced;* for the inductive resistance between the two surfaces on which the two opposite states exist would not, evidently, be altered.

By this means, therefore, the inductive resistance between the electrometer arms, *a*, and the surrounding opposing surface is maintained constant, and cannot be altered by any change in the position of the conductors exterior to it.

The quantity passing to the electrometer will now, however, still be dependent on any alteration in the inductive resistance between the conductor, A, and the surrounding objects, and if the uninsulated body, B, be withdrawn from its position round A, a flow from the conductor, A, to the electrometer will again take place.

We see, therefore, that the quantity may be varied by the several conditions of the case, even when the instrument is connected to a conductor of given size, and charged with a given quantity of electricity. But, although the quantity actually passing to the instrument can be thus varied, the permanent armature surrounding it constantly maintains the distribution on the arms of the instrument the same, whatever the quantity may be passing to it, and, consequently, the effect on the instrument will be entirely dependent on the quantity actually passing to the arms. Thus, suppose the armature of the instrument again insulated, and let the arms, *a*, be connected to the charged conductor A. Then a certain quantity will pass to the arms *a*, producing an equal and opposite state on the interior of the armature, E, which is polarized, and, consequently, has on its outside an equal and similar quantity to that on the arms *a*. This quantity, on the outside of the armature having again its equal and opposite state on the surrounding surfaces. Let, now, the connection between the electrometer and the conductor A be removed; the quantity on the electrometer will remain unaltered. If, now, the position of the surrounding objects be altered, the distribution of the quantity on the exterior of the armature may be altered to any extent, a corresponding change taking place on the opposite charge on the surrounding surfaces. But, from what has already been pointed out with regard to distribution, no effect will be produced on the distribution on the *interior* surface of the armature, or on the arms *a*. And, further, if the armature be connected to the surrounding objects, the charge on its exterior will be neutralized by its equal and opposite state on the surrounding conductors, but no alteration will take place in the distribution on the interior of the armature, and on the arms which, consequently, will exert the same repulsive force as when first charged.

The armature, therefore, even in this case, plays a useful part, for though, if the armature of the instrument is insulated, when the arms are connected to a charged conductor, the total quantity passing to the instrument will be affected by the position of the conductors near it; yet, when the charging connection is removed, the instrument remains indifferent to the position of all conductors external to the armature.

ON THE PERIODS OCCUPIED IN CHARGING DIFFERENT LENGTHS OF TELEGRAPH WIRE, WHEN THEIR DISTANT ENDS ARE TO EARTH.

BY RICHARD LAMING, M.R.C.S.

AUTHOR OF "STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY."

[Continued from p. 162.]

In stating, after reading the leading article in The Electrician,

* Provided, of course, that they are so approached to E as not to affect the inductive resistance *between the conductor, A, and the surrounding surfaces.*

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of August 1st, that the true way for getting at the comparative resistances to charge in wires of different lengths is to trace the course of each individual particle of electricity, my object was to enable the telegraphist to comprehend the physical *modus operandi* involved, as much as to discover the ratio resulting from it; the conviction under which I have always written in these pages being, that empirical mathematical formulæ, however useful they may be in a certain point of view, are hardly less than mischievous to the physicist, unless, at the same time, they explain the relation of cause to effect.

In my desire to make known the method of calculation that I deemed the right one, as soon as possible after the appearance of the article to which I have alluded, I too hurriedly went through some calculations founded upon small units, as the nearest approach to particles, in order to send them in time for the next issue then preparing for the press; and thereby introduced, without perceiving it, an error in the figures which has vitiated the results. It is, however, simply an error of figures, and leaves the proposed method for calculating the resistances unprejudiced; I will at once explain the mistake and rectify it.

At page 161 of The Electrician, of August 8th, it was said: "and to that add $\frac{11}{2}\times100=550$ units occupied by the charge of D G in passing through the whole length of A D, making a total for D G of 825 units; and for the wire A G, of 1,650 units." There should, instead, have been added $11\times100=1100$, because the whole of 11 units had arrived upon D G through A D; and not half that number only as carried into the calculation, for $11\times25=275$ represented $5\frac{1}{2}\times50=275$. The correction thus supplied makes the total resistance to the charge of D G as $275+1100=1375$, and the total for the whole wire A G as $825+1375=2200$, that is four times as great as the resistance in the wire of half its length.

This ratio of the squares of the lengths was said, lower down in the page, to be inconsistent with the Laws of Conductivity given in the "Steps;" if, in writing the article in question, I had taken time to appeal to my own doctrines for guidance, I should have seen that they point in the opposite direction; that is, *to* the ratio of the squares, *not* from it. I have since consulted my own theory, moved to do so by the impossibility of believing, as came out from the false figures, that the resistance for the far end of any wire is not greater than that for its near end, and it immediately sent me back again to revise the calculations that had given me a result so remarkable.

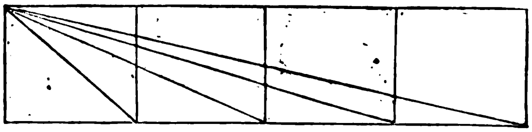
The 3rd Law of Conductivity (Electrician, May 30th, p. 38,) states that *a number of units of charge all moving at the same instant of time*, in their respective units of length, have a sum total of resistance to overcome that is measured by the length of the wire; but the charge of a telegraph wire is the result of successive units of electricity entering and passing along the wire *one after another;* the charge, therefore, by occupying more than one instant of time does not fall under this 3rd Law.

On the other hand, the 1st Law declares that *an unit* of charge in passing through the whole of a wire experiences a total resistance measured by its length. Now, it can be easily deduced from the theory and fact, that the units of electricity in uninsulated wires of different lengths, all charged from the same source, are in number as the respective lengths; so that if we multiply the units by the lengths—that is, the lengths by themselves—we get for the resistances the squares of the lengths. Nor is this result to be objected to on the score of its not being true, in fact, that all the units of electricity constituting a charge pass *from one end of a wire to the other* during its time of charging; because *any* proportionate parts of wires of different lengths that may be found, or assumed, to represent the mean course of all the units of the several charges, multiplied by the respective total lengths, give products that are both proportionate to one another, and also as the squares of the lengths.

Now that I have recalled to consideration the Laws of Conductivity afforded by the theory, I would take the opportunity of remarking that it was not my purpose to apply them, being satisfied with having laid the new view of electrical action, so far as it has yet been traced in these pages, before the rising school of electricians, in order that they may surpass their elders, by themselves discovering and making use of its implications; and I do not hesitate to repeat my conviction that delay in doing so on the part of any one of them will sooner or later be regarded by himself as so much time turned to a less profitable account than it might have been: a theory that has never been found defective may be spoken of with confidence, even by its author.

The method of calculation I have indicated as giving geometrically true results, while representing the physical action in the wire, may be considerably abbreviated. Instead of the figs. 2 and 3, in which the charge at A H was supposed to be divided into 22 units, we may employ the following diagram, in which the charge is undivided into fractions, although its mean course has been found exactly as before.

Fig. 5.



Let there be four parallelograms, A B I K, A C H K, A D G K, and A E F K, all of equal height and increasing in length in arithmetical progression. Let each be divided by the diagonals, K B, K C, K D, and K E, respectively.

Each diagonal will divide its parallelogram into two equal parts, and, therefore, the triangles, K B A, K C A, K D A and K E A, will be to one another in the ratio of 1, 2, 3, 4, because the parallelograms bear these proportions.

As the several triangles, according to Mr. Clark's experiments, represent electrical charges on the uninsulated wires, A B, A C, A D, and A E, it follows that their quantities of electricity will be as their lengths, respectively, that is a double quantity on the double length, a triple quantity on the triple length, and so on.

Now, hitherto, in order to describe the physical facts, the half of the mean length of a number of horizontal lines, supposed to be extended from A K to K B, has been taken as the mean distance which the charge of A B would have to travel; we may, for the same reason, continue to do so. Then the four wires having respectively 100, 200, 300, and 400 units of length, and being charged respectively with 1, 2, 3, and 4 units of quantity, we shall have for A B, $\frac{100}{2}=50$, the mean length from A K to K B; $\frac{50}{2}=25$, the mean course travelled by the charge; and $25\times1=25$ for the resistance. For A C we shall have $\frac{200}{2}=100$, mean length; $\frac{100}{2}=50$, mean course; and $50\times2=100$, for the resistance. For A D $\frac{300}{2}=150$, mean length; $\frac{150}{2}=75$, mean course; and $75\times3=225$, resistance. And for A E there will be $\frac{400}{2}=200$, mean length; $\frac{200}{2}=100$ mean course; and $100\times4=400$ resistance. The series 25, 100, 225, 400, gives the ratio of 1, 4, 9, and 16.

But, apart from the representation of physical theory, and merely for the purposes of calculation, we may have any length, or the whole, of the wire, A B, to represent the course of the charge, provided we take proportionate lengths of all the other lines that we desire to compare with it, because any number we may adopt to represent the length of course in A B will be

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doubled when the course is in A C, trebled when it is in A D, and so on, in order that all the numbers may be maintained in the same relative position with respect to the areas of all the triangles. For avoiding fractions we may, therefore, make use of the whole of the lines, respectively; and represent the resistances as equal to the lengths × the charges; or, which is the same thing, by the general formula

$$i = L^2,$$

in which i is the resistance (or inertia), and L the length of the wire.

While the squares of the lengths thus come out to be the law of resistance to the charge, or of the periods necessary for charging, from a source maintained at any given intensity, different lengths of uninsulated wires; the law of resistance to the passage of electricity, when once the passage is established, is as the simple lengths, because, as was stated when announcing the 300 Law of Conductivity in the 30th number of The Electrician, the quantity of electricity which, at any moment, is being resisted in its passage through a given wire is simply as its length, all other things being the same.

I avail myself of this opportunity to say it has been suggested to me that in announcing the Laws of Conductivity, when they where afforded by the theory, I have used the word *retardation* in a different sense to what is usual with telegraphists; *resistance* would have been less liable to misconstruction, but *inertia*, according to my views, would have been most proper.

IRON COVERED CABLES.

In our last number we quoted at some length the opinions of telegraph engineers and others, upon the subject of corrosion, which has so materially affected the permanency of submarine cables, more especially when submerged in shallow water, as is the case with most of our present cables. Although this cause of danger had been foreseen in time to provide against its recurrence in the expensive line between Malta and Alexandria, still no precautionary measures were adopted, and it is to be feared that, in this instance, as observed by Mr. C. W. Siemens, that "so far from the iron being an element of strength," it will become "an element of actual weakness when the cable requires to be raised for repairs." Indeed, we find that Sir Charles Bright, at the discussion upon Mr. Preece's paper already referred to, recommended that means should be adopted to protect the said cable from corrosion. It will be interesting to some of our readers who have not had the opportunity of reading the ponderous Blue Book, containing the result of the investigations of the late Submarine Telegraph Committee, to learn of the attempts made by some of our ingenious inventors, and enterprising manufacturers, to contrive cables, with a view of avoiding the above serious effect of corrosion, &c.

Mr. Thomas Allan submitted cables of a novel and ingenious construction, dispensing altogether with an external iron coating. The cable consisted of a copper conducting wire, of a large size, covered spirally with a number of steel wires, of guage 25, and coated with an insulating material of the required thickness, the whole finished in a covering of platted jute, &c. One of these cables was weighted to 1787 lbs., and the extension before removing the weights did not exceed ·67 per cent. The permanent extension, upon a length of 20 feet, was =·234 per cent., the return =·443 per cent., and the breaking strain equal to 4698 fathoms. Other specimens had breaking strains of 6348, and 7484 fathoms respectively. Mr. Allan produces a cable which certainly possesses several important advantages, besides that of having its element of strength completely protected from the corrosive influence of water; it is small in bulk, of light specific gravity, great strength, and not liable to kink.

Mr. Godefroy has contrived a cable, in which the conducting copper wire is insulated in either gutta percha or india rubber, outside of which, for strength, a number of steel wires are placed in close parallel lines, the whole being afterwards insulated, or enveloped, with patent cocoa nut gutta percha, and again with two coatings of india rubber waterproof canvas. One of such cables was weighted to 1787 lbs., the extension before removing the weight was =·520 per cent., the permanent extension =·182 per cent., and the return ·338 per cent. This description of cable, like that of Mr. Allan's, is exclusively intended for deep sea lines.

Messrs. Hall and Wells' cable consists of a copper conducting wire covered with india rubber, closely served with tarred thin yarns, a number of longitudinal hemp lines, and longitudinal steel wires, braided together, with strands of hemp, saturated with best Stockholm tar. One of these cables was weighted to 1787 lbs., the extension before removing the weight was =·416 per cent. The permanent extension after removing the weight =·208 per cent., and the return =·208 per cent. This kind of cable is free from liability to kink, has a light specific gravity, combined with great strength. The breaking strain from 5000 to 11,000 fathoms. These gentlemen have recently manufactured a length of core for the Indian Government, but we regret to find that it is to be covered with naked iron wires, and probably we shall have the old story over again, that the *insulator* has failed, and not that which was intended for its protection.

Mr. Sinnock describes his cable as follows:—Core of strands of copper wire covered with gutta percha served with waterproof tape; then 11 longitudinal thick marlin lines, each consisting of 9 tarred yarns, served spirally with hempen string, the whole served with two turned iron wires and three tarred strings. One of his cables was weighted to 1787 lbs. The extension before removing the weight was =1·664 per cent., the permanent extension was =·933 per cent., and the return =·728 per cent. Breaking strain equivalent to 2855 fathoms. This is a compact and exceedingly well manufactured cable.

Messrs. Silver and Co. produce a cable consisting of a copper conductor insulated with india rubber, then served with tarred yarn, outside of which steel wires, in close parallel lines, and covered with platted hemp, saturated with a peculiar compound. The breaking strain equivalent to 2675 fathoms. Messrs. Silver and Co. exhibit several specimens at the International Exhibition, differing in some respect from the above, and which appear to us to be well adapted for the purpose of ocean telegraphy.

Mr. De Bergue's is perhaps the most perfect hempen covered cables hitherto contrived. Very small in bulk, light specific gravity, and great strength. A cable having an external diameter of 8-16ths of an inch breaking strain exceeded 16,000 fathoms. The following is a description of the cable: "A core of 7 strands of copper wire, covered with gutta percha; next 17 longitudinal tarred hempen lines, served with similar sized cord of hemp."

Mr. Latimer Clark proposes a cable of the following description:—An insulated conducting copper wire or core, served with steel wires, having a slight spiral direction, and covered with tape and a composition of shellac and marine glue. A cable of this description was weighted to 1787 lbs. The extension before removing the weight was =·468 per cent., the permanent extension =·364, and the return =·104 per cent., with a breaking strain equivalent to 3,376 fathoms. We believe that the whole of the Liverpool and Isle of Man iron strengthened cable has been enveloped in the above compound, and has remained in a good state of preservation. The Wexford and St. David's Head, as well as the recently successfully laid Zandvoort cable, have also, to a more or less extent, been coated with the above compound, but is it a proof against the inroad of the teredo?

Mr. C. W. Siemens proposes a cable consisting of an insulated copper conductor, covered spirally with strands of hemp, and lapped in a peculiar manner with copper, &c. This cable possesses great strength but we have our doubts as to the character and durability of the proposed external covering.

(To be continued.)

International Exhibition.

JURY AWARDS.

We quote the following from one of the daily journals:—

"There is no lack of fresh murmurs, as well as loud expostulations, against some of the Awards of the Jurors, and in many instances the justice of these complaints has been so convincingly proved, that the Commissioners, it is said, have been shaken in their previous determination to listen to no appeals. The publication of a second edition of the Awards of the Juries has been consented to, in which, no doubt, several amendments in the most flagrant cases of admitted oversight and error will be introduced. The whole system of awarding prizes in connection with industrial exhibitions is called in question by many, and there is, no doubt, much to be said against it. The Society of Arts have undertaken to bring the matter to a settlement, by calling upon the Jurors and the Commissioners for the colonies and foreign countries to express their opinions as to the expediency of awarding prizes on these occasions. The same society has stepped

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forward to carry out the publication of the reports of the Jurors on the progress of the industrial arts since 1851, which the Commissioners had declined to undertake. They will be brought out in a form to correspond with the jury reports of 1851."

We trust that our contemporary's statement will prove to be correct. The awards in Class 13 ought certainly to be modified. The best instruments are ignored, and besides a *medal* is awarded for instruments designed and patented by one of the Jurors. We have the greatest possible regard for Professor Thomson's mathematical abilities and amiability of character, but we must protest against the granting of a medal to a manufacturer simply employed by him to construct his instruments. Let our readers refer to the rules laid down by the Royal Commissioners, and they will find it stated that, "If exhibitors accept the office of Jurors, or Associate Jurors or Experts, they cease to be competitors for prizes in the *class* to which they are appointed, and these cannot be awarded to them individually or to the firms in which they may be partners." Nevertheless, any visitor to the International Exhibition will find that a medal has been awarded to a Mr. James White, of Glasgow, for the following instruments:—

"Thompson's patent marine galvanometer: White and Barr, makers, Glasgow."

Another instrument denominated:—

"Professor Thompson's portable atmospheric electrometer."

On the table there is a card, containing the following information.

"Prize Medal."

"Reasons for the award:—

"Novelty and ingenuity of marine galvanometer. Apparatus for observing atmospheric electricity, and static reaction governor."

We sincerely trust that this extraordinary award will be explained.

APPLIED CHEMISTRY.

On the Cleaning and Preservation of Engravings.

BY AUGUSTUS A. HAYES, M.D., STATE ASSAYER OF MASSACHUSETTS.

The frequent inquiries addressed to me by those who possess valuable engravings—which have become damaged through accident or exposure—respecting a mode I adopted successfully for restoring some very fine ones, induce me to publish a general process, applicable to the largest number of cases.

Any one who will incur the trouble of looking up in the older print shops and depositories in residences in this country, will find abundance of defaced engravings of rare merit, the works of the best masters rejected, which can be restored easily to quite their former degree of freshness and beauty. All who have studied the better efforts of the old artists in giving permanency to their conceptions in this department of art, assign to it a very high place, and it may be suggested that a higher cultivation and enjoyment of design and execution, in so far as the influences of light are concerned, may be gained from careful observation of engravings than can result from time bestowed on paintings which often command public admiration, or are the so-called gems of an exhibition.

In commencing to restore an engraving, some attention must be given to the kind of injury it has suffered. A general brown colour, more or less deep, resulting from atmospheric action only, is the least possible change. Spots and stains caused by ink, coloured fluids, oil, or insects, must be first treated, and all pencil marks removed by india-rubber or bread crumbs. A fluid acid, obtained by dissolving one ounce of crystals of oxalic acid in one-fourth of a pint of warm water, may be used for application to all stains, and the paper should be wet with it thoroughly where spots of any kind exist. Excepting in a few cases, this acid will not cause the removal of stains immediately, but generally it combines with the bases of them, and they are removed by subsequent steps; the thorough wetting should be done a few hours before proceeding to clean the engraving.

To facilitate handling, and for the protection of the edges of the paper, a piece of millinet, or the stiff open fabric formerly sold for ladies' sikrts, should be roughly sewed around one stick at each end, so as to form an apron, like a chart attached to two rollers, the cloth of which must be an inch larger than the largest print to be handled. From one to ten prints of even large size may be cleaned at one time, after they have been wet on their spotted parts with the acid, and evenly spread on the apron, so as to allow of the immersion of the whole in water. A tub of the ordinary size will allow prints of considerable surface to become immersed, but the most desirable resort is a common bathing vessel, so nearly filled with warm water that the bent paper supported by the open texture can rest on the bottom and sides, where it should be allowed to remain, with occasional raising of it, and moving it by means of the stick handles, from twelve to twenty-four hours.

On the first trial a degree of alarm will be felt in the case of a highly-prized favourite at this seeming careless treatment; but it must be borne in mind that paper is a firmly felted mass of short fibres which may be soaked in various fluids for weeks, and resist all diluted acids, and most chemical agents, for a long time wet, if not exposed to mechanical abrasion by touch or rapid motion. The strong paper of engravings absorbs much air, which resists the penetration of the water, and motion is necessary to remove this, as well as to allow the coloured solutions formed to pass away. This motion may be given by holding the supporting sticks and passing the mass from end to end of the bath, or slowly up and quickly down, enabling the sheets to become separated momentarily. Discoloured water may be drawn off, the apron and contents resting on the bottom and sides, and fresh water be slowly admitted to replace it. Cold water can be substituted for warm, longer time being allowed for its action. When the prints no longer add colour to the water after being agitated, the water must be withdrawn and replaced by such a portion as will barely cover the paper. Half a pound of bleaching powder (chloride of lime) mixed to a paste first in cold water, and then added to two quarts of cold water, and well stirred from time to time for six hours, will afford a nearly clear fluid resting on a white deposit in the earthenware vessel. A portion of the clear part of this fluid must be added to the water in the bath, until both taste and odour denote the presence of chlorine in the water. Motion being given to the paper, the bleaching effect of chlorine will be perceived, or its odour in the water will have been lost, when more must be added, so that the odour or taste of chlorine must be present in the water two or three hours.

The action of the chlorine on the parts previously wet with the acid will remove nearly every kind of discoloration, while the brown hue of the paper giving place to perfect whiteness, the light and shadows of the engraving become of their original perfectness, and the picture will be as distinct as when it was first impressed. It has happened in a few trials, when the prints were long stained, they did not yield to the weak chlorine water, that resort was to have a little mineral acid to develop free chlorine in the bath. One ounce of muriatic acid was added to one pint of cold water, and the weak acid thus formed mixed in the water of the bath, soon caused the bleaching of every fibre in the paper.

After the bleaching the water must be drawn off, the paper drained, fresh clear water admitted, and the paper moved through the water to thoroughly wash away all adhering chlorine. Several quantities of water may be used, the paper being each time drained; and finally, the whole mass, raised by the handles, may be placed on a clean white wood table, or board, to drain. If a number of prints have been treated, the wet mass may be placed in a warm room, or air may be admitted, and as the one on the top of the pile becomes more dry than the rest, it may be removed to any support, and left to dry. In hastening the drying I have extended ordinary bed sheets and spread the went prints singly on these, slow drying rendering any pressing unnecessary.

Those having the usual presses might prefer to press the still damp sheets, and where only two or three prints are the subjects of trial, the substitution of other vessels and ready appliances will occur to any one.

This description is given in detail purposely, although unnecessary, so far as the process is concerned, because I wish to impress on the mind of any one who possesses an injured engraving, that it can be restored to its original value without the expenditure of much attention; and it must not be the conclusion, from reading this process, that great care is required, for time is insisted on rather than attention. The few dispositions being made, not the slightest care need be given to the matter. If the bath can be spared, the odd minutes of a week will enable one to restore dozens of specimens, and give permanency to their beauties.—*Scientific American.*

PHYSICAL SCIENCE.

On the Utilisation of the Power involved in the Rise and Fall of the Tides.

The tendency of modern scientific discovery has been to show that all the various forms of force with which we are acquainted, are mutually convertible into one another. Thus, of the six forces known to us in connection with the universe—gravitation, motion, light, heat, electricity, and chemical affinity—it is well known that any one of the five latter is capable, by appropriate means, of generating the other four, the force of gravitation being capable, through the medium of motion, of giving rise to the other five forces, whilst it cannot itself be generated. Gravitation may therefore be assumed to be the elemental force, since it is the only one of the six which will generate all the others. So accurately have these correlations been studied, that the quantitative value of gravitation has even been ascertained, it having been found that the mechanical force required to lift 772 pounds to the height of one foot is capable, when converted into the force of heat, of raising the temperature of one pound of water 1° F. In other words, this amount of heat may be generated by an appropriate utilisation of the gravitating pull, exerted by a weight of 772 pounds during its downward movement through the space of one foot. Supposing, therefore, we were in possession of an unlimited number of 772-pound weights, and were to employ in the most judicious manner the force thus evolved in their downward progress, we should have an unlimited reservoir of power which could be converted at will into light, heat, electricity, or chemical affinity, and could be made to toil for human benefit without any corresponding

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expenditure of human labour so long as the weights continued their downward progress unarrested. If, however, any good were to be gained by such a machine, it must be managed so that the motive force—gravitation—should always remain on the pull, and this is, and ever will be, the obstacle to the attainment of perpetual motion; the act of overcoming the force of gravity to re-raise the weights requiring the expenditure of exactly the same amount of power as has been generated during their downward fall; and so, before we can seriously discuss the feasibility of such a machine, we must find a perpetual flow of gravitating force always at hand, craving to be satisfied, and yet inexhaustible. In other words, we must construct a clock which will wind itself up when the weight has run down without any expenditure of human power.

Sitting by the sea-shore a few days since, we could not help noticing the vast reservoir of mechanical power existing in the ocean. We do not refer to the noisy dash of the waves as they break upon the beach, but to the infinitely mightier, although silent and progressive, energy exerted in the gradual rise and fall of the tides. Compared with the stupendous power capable of being utilised for man's benefit, and present in the rise or fall of millions upon millions of tons of water through a space of ten or twenty feet four times a-day, all the steam, water, or wind power in the world, together with the united muscular force of every living being, human and animal, sink into utter insignificance. We will try to form some idea of this power. Let us suppose that by the action of the tides the difference of level of the surface of the ocean at a certain spot is 21 feet between high and low water; omitting for the present all consideration of the power of the subjacent liquid, what is the mechanical value of a space of 100 yards square of this water? 100 yards square by 21 feet deep equals 70,000 cubic yards of water, which is lifted to a height of 21 feet, or to 1,470,000 cubic yards lifted to a height of 1 foot. Now, since one cubic yard of water weighs about 1683 pounds, 1,470,000 cubic yards weigh 2,474,010,000 pounds, which is lifted in six hours. This is equivalent to lifting a weight of 412,335,000 foot pounds in one hour; and since one horse-power is considered equivalent to raising 1,800,000 foot pounds per hour, we have locked up in every 100 yards square of sea surface, a power equal to a 230 horse-power steam-engine, acting, be it remembered, day and night to the end of time, requiring no supervision, and costing nothing after the first outlay but the wear and tear of machinery.

By means of appropriate machinery connected with this tidal movement, any kind of work could be readily performed. Water could be hoisted or air compressed to any desired extent, so as to accumulate power for future use, or for transport to distant stations. Light of surpassing splendour could be generated by means of magneto-electric machines; and with a very little exercise of ingenuity, every lighthouse on the coast could be illuminated with sun-like brilliancy, and with absolutely no expenditure of fuel; the very same mechanical power of the ocean, which, in its brute force, would dash the helpless vessel to pieces against the rocks, being bound and coerced like the genii in Eastern tales, and transformed by man's intellect into a luminous beacon to warn the mariner against the approach of danger.—*Chemical News.*

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

Very little enquiry.

Para, fine	1s. 11d. to 2s. per lb.
Java	1s. 5d. "

GUTTA PERCHA.

Dull market.

Fine	2s. 6d. per lb.

August 20, 1862. WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic, A.	100	50 to 55	——
20	Do. B 7 per cent. till 1862 .	all	19 to 21	——
Stock	Electric Telegraph . .	100	99 to 102 x.d.	——
5	London District Telegraph .	$4\frac{3}{4}$	$4\frac{1}{4}$ to $3\frac{3}{4}$ dis.	——
10	Mediterranean Extension Tel.	all	$3\frac{1}{2}$ to $4\frac{1}{2}$ x.d	——
1	Submarine Telegraph, scrip.	all	$\frac{3}{8}$ to $\frac{5}{8}$	——
1	Do. registered . . .	all	$\frac{3}{8}$ to $\frac{5}{8}$	——
10	Do. " . . .	all	4 to 6	——
2	Telegraph to India . .	1	$\frac{5}{8}$ to $\frac{3}{8}$ dis.	——
5	United Kingdom Telegraph .	8	$\frac{1}{2}$ dis. to par.	——

THE PROGRESS OF TELEGRAPHY.

THE extension of the advantages of Telegraphy is a subject which all must regard as one of the utmost importance to the well-being of society. A simple, cheap, and expeditious mode of interchanging thought is not less valuable than that of the present system of railway and marine transit. The beneficial effects of railway and steam navigation have been socially and commercially appreciated, and hence the success which has attended their development. Telegraphy has been too much the toy of philosophers. An attempt has been made to involve the science of telegraphy in mystery, for the benefit of the "few," and it is with the greatest pleasure that we now place before our readers, in simple words, the present aspect, and from which they may form an opinion of the future prospects of telegraphy. Commercially speaking, telegraphic enterprise has for some time been a "drug on the market," especially submarine telegraphy. The report of the half-yearly meetings of telegraphic companies held recently are exceedingly encouraging. The Directors of the Electric and International Telegraph Company, in their report, state that there has been a "steady improvement at many of the numerous stations of the company, unaffected by competition," and that an increase of 167 stations has taken place within the year. They also state that, in despite of competition, their revenue upon the half-year shows an increase. They also state that they have extended their operations by the construction of a submarine line between South Wales and Wexford, in Ireland, at an expense of £51,061, and this line remains in perfect condition, and is a valuable adjunct to their already extensive net work of telegraphy in the United Kingdom; and they have, since the publication of their report, submerged a line of submarine telegraphy between our shores and Zandvoort. The core was manufactured by the Gutta Percha Company, and sheathed at the establishment of Messrs. Glass, Elliott, and Co., at Greenwich. The company at present possesses no less than 841 telegraphic stations in constant communication with 3,500 telegraphic stations on the Continent of Europe.

The last report of the British and Magnetic Telegraph Com-Company, shows that this important undertaking is in a healthy and prosperous condition; the stations and the messages are increasing in number, and the company's submarine cables are in good working order.

The Telegraph to India Company, although the attempt to recover the Red Sea lines was unsuccessful, derives an ample revenue from the short line recovered between the island of Jubal and Suez. This augurs well for the future; and the commercial value of a great Indian line of telegraphy is fully established by this fact alone. And moreover, the causes which have led to the failure of the lines of the great Red Sea Telegraph Company are ascertained.

The London District Telegraph Company's report is very encouraging. It is evident that the advantages of private and local commercial telegraphy is becoming daily more fully appreciated. The increase in the company's revenue is the more satisfactory because it is gradually progressive. It is to be regretted that the post-office and the police and fire establishments do not avail themselves of the great advantages afforded them by this company. We ourselves are under great obligations for the facilities of communication afforded us by the London District Telegraph Company.

The Mediterranean Telegraph Company has at last appeared amongst its compeers as a "paying" undertaking—long may it remain so.

Considering, therefore, the present aspect of telegraphy in a commercial point of view, we cannot do otherwise than arrive at the conclusion that there looms in the future a brilliant prospect for telegraphic enterprise both by sea and land.

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ELECTRIC ILLUMINATION FOR LIGHTHOUSES.

The following is the abstract of a paper by Professor Faraday, which was read at the Royal Institution in March 1860 :—

The use of light to guide the mariner as he approaches land, or passes through intricate channels, has, with the advance of society and its ever-increasing interests, caused such a necessity for means more and more perfect, as to tax to the utmost the powers both of the philosopher and the practical man, in the development of the principles concerned, and their efficient application. Formerly the means were simple enough; and if the light of a lanthorn or torch was not sufficient to point out a position, a fire had to be made in their place. As the system became developed, it soon appeared that power could be obtained not merely by increasing the light, but by directing the issuing rays; and this was, in many cases, a more powerful and useful means than enlarging the combustion; leading to the diminution of the volume of the former, with, at the same time, an increase in its intensity. Direction was obtained, either by the use of lenses dependent altogether upon refraction, or of reflectors dependent upon metallic reflexion; and some ancient specimens of both were shown. In modern times, the principle of total reflexion has also been employed, which involves the use of glass, and depends both upon refraction and reflexion. In all these appliances much light is lost. If metal be used for reflexion, a certain proportion is absorbed by the face of the metal; if glass be used for refraction, light is lost at all the surfaces where the ray passes between the air and the glass; and also in some degree by absorption in the body of the glass itself. There is, of course, no power of actually increasing the whole amount of light, by any optical arrangement associated with it.

The light which issues forth into space must have a certain amount of divergence. The divergence in the vertical direction must be enough to cover the sea from the horizon to within a certain moderate distance from the shore, so that all ships within that distance may have a view of their luminous guide. If it have less, it may escape observation where it ought to be seen; if it have more, light is thrown away which ought to be directed within the useful degree of divergence; or if the horizontal divergence be considered, it may be necessary so to construct the optical apparatus, that the light within an angle of 60° or 45° shall be compressed into a beam diverging only 15°, that it may give in the distance a bright flash having a certain duration instead of a continuous light—or into one diverging only 5° or 6°, which, though of far shorter duration, has greatly increased intensity and penetrating power in hazy weather. The amount of divergence depends in a large degree upon the bulk of the source of light, and cannot be made less than a certain amount with a flame of a given size. If the flame of an argand lamp, seven-eighths of an inch wide and one and a half inches high, be placed in the focus of an ordinary Trinity-house parabolic reflector, it will supply a beam having about 15° divergence; if we wish to increase the effect of brightness we cannot properly do it by enlarging the lamp flame; for though lamps are made for the dioptric arrangement of Fresnel, which have as many as four wicks, flames 3½-inches wide, and burn like intense furnaces, yet if one be put into the lamp place of the reflector referred to, its effect would chiefly be to give a beam of wider divergence; and if to correct this the reflector were made with a greater focal distance, then it must be altogether of a much larger size. The same general result occurs with the dioptric apparatus; and here, where the four-wicked lamps are used, they are placed at times nearly 40 inches distant from the lens, occasioning the necessity of a very large, though very fine, glass apparatus.

On the other hand, if the light could be compressed, the necessity for such large apparatus would cease, and it might be reduced from the size of a room to the size of a hat; and here it is that we seek in the electric spark, and such like concentrated sources of light, for aid in illumination. It is very true, that by adding lamp to lamp, each with its reflector, upon one face or direction, power can be gained; and in some of the revolving lights ten lamps and reflectors unite to give the required flash. But then not more than three of these faces can be placed in the whole circle; and if a fixed light be required in all directions round the lighthouse, nothing better has been yet established than the four-wicked Fresnel lamp, in the centre of its dioptric and catadioptric apparatus. Now the electric light can be raised up easily to an equality with the oil lamp, and if then substituted for the latter, will give all the effect of the latter; or by expenditure of money it can be raised to a five or tenfold power, or more, and will then give five or tenfold effect. This can be done, not merely without increase of the volume of the light, but whilst the light shall have a volume scarcely the 2,000th part of that of the oil flame. Hence the extraordinary assistance we may expect to obtain of diminishing the size of the optical apparatus and perfecting that part of the apparatus.

Many compressed intense lights have been submitted to the Trinity-house; and that corporation has shown its great desire to advance all such objects and improve the lighting of the coast, by spending, upon various occasions, much money and much time for this end. It is manifest that the use of a lighthouse must be never failing, its services ever sure; and that the latter cannot be interfered with by the introduction of any plan, or proposition, or apparatus, which has not been developed to the fullest possible extent as to the amount of light produced—the expense of such light—the wear and tear of the apparatus employed—the steadiness of the light for 16 hours—its liability to extinction—the amount of necessary night care—the number of attendants—the nature of probable accidents—its fitness for secluded places, and other contingent circumstances, which can as well be ascertained out of a lighthouse as in it. The electric spark which has been placed in the South Foreland High Light, by Professor Holmes, to do duty for the six winter months, had to go through all this preparatory education before it could be allowed this practical trial. It is not obtained from frictional electricity, or from voltaic electricity, but from magnetic action. The first spark (and even magnetic electricity as a whole) was obtained twenty-eight years ago (Faraday, "Philosophical Transactions," 1832, p. 32). If an iron core be surrounded by wire, and then moved in the right direction near the poles of a magnet, a current of electricity passes, or tends to pass, through it. Many powerful magnets are therefore arranged on a wheel, that they may be associated very near to another wheel, on which are fixed many helices with their cores like that described. Again, a third wheel consists of magnets arranged like the first, next to this is another wheel of the helices, and next to this again a fifth wheel, carrying magnets. All the magnet-wheels are fixed to one axle, and all the helix wheels are held immoveable in their place. The wires of the helices are conjoined and connected with a commutator, which, as the magnet-wheels are moved round, gathers the various electric currents produced in the helices, and sends them up through two insulated wires in one common stream of electricity into the lighthouse lanthorn. So it will be seen that nothing more is required to produce the electricity than to revolve the magnet-wheels. There are two magneto-electric machines at the South Foreland, each being put in motion by a two-horse power steam-engine; and, excepting wear and tear, the whole consumption of material to produce the light is the coke and water required to raise steam for the engines, and carbon points for the lamp in the lanthorn.

The lamp is a delicate arrangement of machinery, holding the two carbons between which the electric light exists, and regulating their adjustment; so that whilst they gradually consume away, the place of the light shall not be altered. The electric wires end in the two bars of a small railway, and upon these the lamp stands. When the carbons of a lamp are nearly gone, that lamp is lifted off and another instantly pushed into its place. The machines and lamp have done their duty during the past six months in a real and practical manner. The light has never gone out through any deficiency or cause in the engine and machine house; and when it has become extinguished in the lanthorn, a single touch of the keeper's hand has set it shining as bright as ever. The light shone up and down the Channel, and across into France, with a power far surpassing that of any other fixed light within sight, or anywhere existent. The experiment has been a good one. There is still the matter of expense and some other circumstances to be considered; but it is the hope and desire of the Trinity-house, and all interested in the subject, that it should ultimately justify its full adoption. M. F.

Telegraphic News.

MILITARY TELEGRAPHY.

The following letter has appeared in the *Times* upon the above important subject, and to which attention has been directed upon several occasions in the columns of this journal. We believe that experiments are now being carried on with a view of adopting such a plan by our military authorities.

To the Editor of The Times.

Sir,—In your Paris Correspondent's letter of the 15th inst. the following passage occurs :—

"A letter from the camp at Châlons of the 11 inst. says :—'We are decidedly becoming more lively. . . . The manœuvres to day were particularly interesting, on account of the telegraphic experiments which were made under the direction of Count Vougy, Director General of

Telegraphs, who came to the camp specially for that purpose. The Marshal left one of his officers in his tent with an electrical apparatus and he himself was followed by a carriage in which was another apparatus, by which he was enabled to communicate at pleasure with his head-quarters. I am informed that a carriage prepared for the occasion may easily carry a wire 15 miles long. The importance of such a machine during a campaign may be easily imagined."

Are we not going to prepare ourselves also, and take a hint from the foregoing?—I remain, Sir, your obedient servant, X.

Edinburgh, August. 16.

PROGRESS OF SUBMARINE TELEGRAPHY.

We had recently to announce the successful submersion of the first portion of a new telegraph cable between England and Holland, the property of the Electric and International Telegraph Company, we have now the pleasure of announcing the successful submersion of the remaining part.

Messrs. Wells & Hall have completed the core for the Indian Government, and the same is now being sheathed at Mr. Henley's Manufactory, North Woolwich.

THE LONDON DISTRICT TELEGRAPH COMPANY. (LIMITED.)

The seventh half yearly meeting of the Shareholders of this Company was held at the offices, 90, Cannon-street, on Friday, the 15th inst., Mr. Robert Taylor in the chair.

The report of the Directors has already appeared.

The Chairman, in moving the adoption of the report, said it was a matter for congratulation that the Company had, during the past six months, progressed in a most satisfactory manner, the receipts having increased to the extent which they were at the time of the last meeting justified in expecting. The capital account might be considered as closed, as there remained only 5s. per share to be called up. There was a sum of £2,588 entered in the accounts as arrears of calls, which was more than appeared in the last half-yearly balance-sheet; another call, not completely responded to, having been made since then. Every exertion had been made to get in the arrears, and it was under consideration to cancel those shares which were in default. There had been an equal amount of industry exhibited in keeping down the expenditure, and on a comparison of the accounts for the past half year with those for the corresponding period of 1861 there was a reduction upon almost every single item. They had thought it unnecessary to retain the services of an engineer now that the work of construction was over, especially as they had now as their colleague on the board a gentleman of such electric experience as Sir Charles Bright. They had earned a gross revenue of £6,513 18s. 4d., or, deducting the charges of other companies, £3,956; and, after defraying all the expenses of management, they had in hand a balance of £1,077 15s. 4d. It was encouraging to mark the increase in the number of messages. For the June half of 1860 they numbered 26,115; for the same period last year they were 64,785, and now they were nearly double that, being 123,280. It might be considered that the International Exhibition had led to that increase, but the fortnightly returns from the 10th of January had systematically increased, and only two months of the six were affected by that great international gathering. It was, therefore, but reasonable to conclude that the result was owing to the healthy condition of the Company.

Mr. Eames seconded the motion, and expressed himself greatly satisfied with the improved condition of the Company, in the ultimate success of which he was now more confident than ever. He wished to know how much of the arrears of calls might be looked upon as good debts. He was rejoiced to see Sir Charles Bright in the direction of the Company.

The Chairman replied about £1,500 of the arrears were good debts.

Mr. Mitchell observed that if the Company went on working at a loss of £2,000 per annum, they would soon run through the whole of their capital. They were, too, in debt about £1,450. He said that the amount of the shares purchased by the Company had increased since the last meeting, and he wished for some explanation on that point.

The Chairman replied that he had no doubt the Company would this year clear its expenses, so that there was no reason to apprehend the total absorption of the capital. They had not purchased any other shares, but having paid the last 5s. call on those they already held, they had, of course, to add that amount to their cost in the Company's books, and hence the difference in accounts noticed by the honourable proprietor.

After some further explanations, the report was adopted, and the proceedings closed in the usual manner.

Dr. Share Account. *Cr.*

Dr.	£ s. d.
To Capital authorised, viz.:— 12,000 Shares, at £5 each	60,000 0 0
	£60,000 0 0

Cr.		£ s. d.
By Shares unissued, 1,260 at £5		6,300 0 0
„ Capital uncalled, 10,740 at 5s.		2,685 0 0
„ Capital called, viz.:—		
Deposit, £1 per Share	£10,740	
Call (1st), £1 per Share	10,740	
Call (2nd) 10s. per Share	5,370	
Call (3rd), 10s. per Share	5,370	
Call (4th), 10s. per Share	5,370	
Call (5th), 10s. per Share	5,370	
Call (6th), 10s. per Share	5,370	
Call (7th), 5s. per Share	2,685	
		51,015 0 0
		£60,000 0 0

Balance Sheet.

Dr.		£ s. d.
To Capital called ...	£51,015 0 0	
Less Calls unpaid ...	2,588 0 0	
		48,427 0 0
To Sundry Creditors		3,301 10 5
		£51,728 10 5

Cr.		£ s. d.
By Amount expended as per last Account	£34,842 6 0	
„ Subsequent Expenditure, viz.:—		
Construction of Works	666 1 10	
Office Fittings	67 18 6	
Salaries	184 7 6	
Law Charges	174 18 6	
Advertising, Printing, &c.	73 6 0	
		36,008 18 4
„ Instruments, Batteries, Stores, Tools, Implements, and Furniture		3,944 18 3
„ Frank Stamps in Hand ...		3 7 2
„ Shares purchased in trust for Company		684 10 0
„ Sundry Debtors		1,652 9 8
„ Cash at Bank, &c.		689 7 10
„ Balance of Profit and Loss Account, as per previous Account	£7,667 8 10	
„ As per Account, 30 June, 1862	1,077 15 4	
		8,745 4 2
		£51,728 10 5

Profit and Loss Account.

Dr.		£ s. d.
To Rents, Rates, Taxes, &c.	£1,635 8 6	
Less Rents of Premises Sub-let	548 15 5	
		1,086 13 1
To Gas and Water Rates, Coals, &c.		112 10 11
„ Direction		125 0 0
„ Audit		15 15 6
„ Salaries		331 17 9
„ Wages, &c.		2,180 12 11
„ Stationery		278 3 7
„ Printing, Postages, &c.		63 0 9
„ Repairs and Maintenance		687 12 7
„ Porterage and Travelling Expenses		41 2 5
„ Charges		155 8 11
		£5,077 17 11

Cr.		£ s. d.
By Revenue from Messages, Rents of Private Wires, &c. ...	£6,513 18 4	
Less Charges of other Companies	2,557 13 8	
		3,956 4 8
„ Interest on Unpaid Calls, &c.		43 10 5
„ Transfer Fees		0 7 6
„ Balance		1,077 15 4
		£5,077 17 11

We have examined the foregoing Statements with the Vouchers and the Company's Books, and find the same correct.

M. CHUBB,
EDWD. SANDELL, } Auditors.

London, 11th August, 1862.

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Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of The Electrician.

Sir,—I am a reader of your valuable paper, and will thank you to answer the following question, for I am in a fix.

Does electricity pervade the whole substance of a copper wire, or only pass along its surface? or, will a wire *double* the diameter of another convey *four times* the quantity according to its sectional area (as stated by Dr. Lardner in the "Museum of Science), or only *twice* the quantity according to their respective circumferences or external areas?

By answering the above, sir, you will enlighten and gratify your most obedient servant, B. Ballard.

20, *King Street, Bartholomew Square, St. Lukes.*
August 18*th*, 1862.

[If our correspondent will refer to the "Report of Telegraph Committee," p. 77, Vol. I, of the Electrician, he will find the information he requires.—Ed. E.]

To the Editor of The Electrician.

Sir,—In Mr. Preece's paper "On Railway Telegraphs" the cut No. 4 in your last number is incorrect. The instrument is supposed to be at Pinner with Harrow on the south and Bushey on the north. Then, if a train is proceeding down the line from Harrow to Pinner the Harrow needle will be blocked by Pinner as shown, and the Bushey needle should also be blocked by Pinner to "line clear," whereas, in the diagram, the Bushey needle is represented as being blocked to "line clear" by Bushey, which is evidently wrong. When a train is passing from Pinner to Bushey, the latter blocks to "train on line" during its passage, and when it has cleared him (Bushey) he signals "line clear" to Pinner, who blocks to "line clear" until another train enters the length.

I think it is necessary to point out a small matter like this, because it might mislead those not conversant with the system.—Yours obediently,
Geo. G. Newman.

Manchester, August 18*th*, 1862.

TEXTS FROM THE BLUE BOOK.—No. 4.

To the Editor of The Electrician.

"Generally speaking, the more perfect the insulating property of the material is, the less is its inductive capacity. There are, however, several apparent exceptions to this rule among the experiments made; but there are so many causes to affect the experiments on insulation that we are not warranted to infer, from these exceptions, the entire independence of the two properties."—*Government Report*, page xxii.

Sir,—From this it would appear that it is not altogether impossible for the cream of cultured creation—a Government Committee—to flap and flounder among the uncertainties. All floundering is undignified in the eyes of the world, who would rather a man boldly aver such and such an axiom at a venture, even at the risk of his utter confusion at some future time, than to express any dubiety as to whether a proposition should receive a negative or an affirmative treatment; this is unjust, we know, since the world is often discovered wholesale in the same pitiable predicament, if pitiable it be; and I dare say I shall be justly charged with having given utterance to a truism if I say that this same rudderless uncertainty makes up the sum total of individual existence, and yet, to all appearance, to ninety-nine one hundredths of humanity, there is nothing in the whole circle of their complex existence but is as plain to them as the added up result of two and two. Now this is one of the greatest evidences that we live in an artificial state of society, and just note how it operates; having attained to that stilted position, which (so we fancy) enables us to take in at one sweeping glance the whole horizon of created entities, forgetting all the time that our unnatural eminence has dimmed the vision to such an extent that we cannot tell whether it be a crow or an ox feeding yonder; we have been manufacturing that everlasting fitness of things, whereby eminent professors, and eminent men who are not professors, fit us to the most exact nicety with every imaginable bit of humbug which we in our lofty position require. These men may set up a sham, a pretence, a gilded nonentity, and by incessantly ringing it into the world's only too willing ears, they succeed in an incredibly short time in passing off their tinsil for pure gold; we are so lofty, how can we tell the difference, and then their noise is grateful music, and the incense offered up redolent to our nostrils: these are some of the fine certainties which we lovers of the positive revel in. Here is a man, however (where? we span the bridge of our nose with the latest improvement from the optician; yes, we think we do see something), who has the genuine stuff in him; he may be a poet, a statesman, a true son of science, who can see deeper by far into the recondities than any of his contemporaries; he has possession of the Promethean spark, and can "snatch living fire from off the sacred mount;" but he is in the valley, and, moreover, diffident, and estimates his possessions at too low a figure, perhaps he is unconscious of their real value; hence, if he venture on development he is startled at his own audacity, and the world, which mistakes shyness for incapacity, extinguishes him with its ridicule and unbelief. Here are unmistakeable certainties snuffed out and buried in oblivion by the world's obtuseness; while, on the other hand, mere bubbles are eagerly sought after, believed in, and treasured, because, brass, bounce, and bravado blow the brazen trumpet.

For the life of me can I see what this has to do with the text though. I hasten back. Now, if our text had said roundly and unflinchingly, "The more perfect the insulating material is the less is its inductive capacity, it would have been treated with more respect, and quoted as an authority; but the Committee were honest men, and would not, therefore, say with their lips what they could not with their consciences endorse: in this case, however, we think they might have gratified the world's hankering after the positive, without risking the possibility of a single twinge in that sensitive part. Some things are so apparent that one is quite justified in speaking positively, although not in a position to prove clearly to one's self even, that such and such matters are what you assert them to be, and this is one of them, although not beyond the reach of the proof required to substantiate it. I could have wished, therefore, the Committee had spoken unequivocally here, even at the risk of exciting the pugnacious propensities of a host of controversialists. As it is, it is something like saying this matter is perfectly straight, only it is rather crooked; or, as John Smith said of his spouse, "tolerably well, but suffering from a pain in the pericranium."

The main question involved in the text is:—What constitutes perfectness of insulation? And, this point settled, the rest of the subject, I take it, will be comparatively easy. To the superficial observer this would appear a very simple question, and one which almost any novice might correctly answer. "Is not that material the most perfect insulator (supposing such an one to exist), which is just the negation of the most perfect conductor? or, in other words, which, being a perfect non-conductor, admits of no induction whatever, so that if you charge a wire therewith insulated to an amount represented by 8, it shall give its charge in full at the other end to the amount of 8, whatever the length of the cable may be?" And this is sound and logical argument, supposing it possess certain other essential qualifications necessary for the office it has to fulfil.

If such a material at this could be found, and one which combined therewith perfection of every other insulating requisite, the matter would be settled, and I should have no possible excuse for the present preaching; but it cannot be, and it is unnecessary for me to say that we never do find perfection in anything; this is supposed to be a peculiarity which distinguishes our planet from all the universe beside; it is true of our triple world—moral, physical, material. The man you look up to as worthy of all imitation—the paragon of moral rectitude, has a skeleton in his closet which would scarify you.

I know you adore an angel, young romancer, but let me not damp your devotion; it is by no means derogatory if I say your idol is only a low type of humanity in some things. And as to physical perfection, it is a most gilded untruth which all of us hypocritically profess to believe in at a certain period of our lives; but we are ever so much wiser now, some of us, which is certainly a comfort. And material perfection, which brings the erratic steed back again into the neighbourhood of our subject, is equally mythical.

Assuming, however, the existence of a material whose inductive capacity is *nil*, it does not necessarily follow, on that account, that it is a perfect insulator. And here I will try to explain what I think constitutes perfectness of insulation; premising, however, that this is a matter which requires to be dealt with, not in an abstract and theoretical way, but in its practical application to actual and existing requirements. My idea of a perfect, or proficient, insulator is a material which possesses every insulating requisite in the highest degree; and I do not think we can give a better idea of it than by enumerating the requirements of a wire destined for the core of a submarine cable. A low inductive capacity is the first, and, perhaps, the most essential requirement; and as the cable will necessarily undergo some rough handling in the process of manufacture, testing, and submersion, it is no less desirable that the insulating material should be tough, homogeneous, flexible, and elastic; further, it should be of such a pliable character as to render it easy of manipulation, in order that it may be applied to the wire effectively; by this I mean that it should be capable of such application as to ensure uniform centricity of the conductor, with no possibility of divergence; durability, and a capacity of withstanding a higher temperature than any known climate, would, I think, about complete the catalogue. These, I conceive, to be the absolute requirements of a submarine, or subterranean conductor, and perfection of insulation is to be found in that material only which supplies these desiderata, one and all, in the highest degree. On the other hand, it is manifest, that any material possessing but one or more of these qualities, in however superior a degree, and lacking the others, or only possessing them to a limited extent, cannot be considered other than an inefficient insulator.

A compound which formed the subject of our last holding-forth is a case in point; this material is eminent for its low inductive capacity—a most invaluable quality, truly; but, then, as it is only meagrely endowed

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with some others little less important, and totally lacks the residue, it can scarcely be deemed superior to the gum it was intended to supersede, the short-comings of which have led to such commendable and praiseworthy efforts.

Having thus demonstrated what constitutes perfection of insulation, suppose we briefly consider if the subject affords any grounds for the uncertainty expressed in the text. Preliminary, however, it will be as well to settle the matter as to whether the material is to be found which combines within itself the necessary insulating properties enumerated above, in a sufficiently high and uniform degree as to render it suitable, above all others, for submarine telegraph insulation.

Experience incontestably proves that gutta percha possesses most of the requisite qualities, but only to a limited extent. Of the compounds invented as substitutes for that gum, some are apt illustrations of the proverb, "the cure is worse than the disease," while others combine infinite superiority with infinite inferiority, reminding one of a giant with diminutive legs; while gutta percha might be fitly typified by a five foot nothing specimen of humanity, tolerably proportional, but of so weakly a constitution, and moreover, calf-less.

Manifestly we don't find the *ne plus ultra* among these; and perhaps we might search creation through, even were we gifted with the intuitive perception of all the secrets of nature, and yet fail in discovering such an insulating material as perfection-mongers desire, or as the most moderate of us could wish; and so it is, we no sooner extort a secret from the reluctant dame, then we run wild with expectations and anticipations, which certainly our good fortune hardly warrants. It does not follow that because, having dispensed with equine assistance, we can travel from one end of the world to the other, literally on the wings of the wind, we should expect to take a holiday trip through the universe also. When such an exploit as that takes place, you, I suspect, will have done with mundane affairs utterly.

Now in this matter, our all-bountiful benefactress supplies us with the very thing for swathing this subtle and errant element—electricity. This material seems to have been created for this special purpose; for notwithstanding the multifarious and indispensable applications to which it is subjected, this one of insulation is of more importance than all the others in the lump. I need scarcely say that I refer to india rubber; and it is supererogatory to catalogue its excellencies, *i. e.*, an inductive capacity all but *nil*, tough, elastic, durable, is uninjured by high temperatures, can be applied to the wire so as to secure its undivergible centricity, can be rendered homogeneous, and will bear any reasonable amount of the unreasonable twisting, bending, straining, jerking, and general ill-usage to which submarine cables are subjected.

Thus have we found the most perfect insulator, and we see that the principal proof of its perfectibility is its having a lower inductive capacity than any other material; well this appears to me to settle the question; where can the doubt and uncertainty be? Suppose the inductive capacity of perfect insulation to be represented by 2 at a given thickness of the dielectric, you surely would not mistake that number for 4, or get the impression into your head that 2 is a variable number, and had fallen from the debateable regions. If you purchase a No. 16 copper wire, you know that the metal has a certain specific gravity, as well as a certain breaking strain; these are qualities which help to make up the perfect metal, as much so as your probocis is necessary to complete the perfect contour of your countenance, and in pure copper uniformly welded these qualities are not variable, and may always be depended on, whatever the numerals may be which represent them; indeed, if it were not for the exactness arrived at in these matters throughout the whole range of mechanics, what would become of all the calculations based upon such unstable data? And no less certain is it, that perfect insulation by means of the best insulator will always show one uniform rate of inductive discharge, if it do not be sure that it proves one of two things, or both combined—bad workmanship and inferior commodity. There should, therefore, be no "generally speaking" in the matter, "*the more perfect the insulating property of the material is, the less is its inductive capacity,*" is an axiom as incontrovertible as that the lines of an equilateral triangle are of the same length.

The text goes on to say that there are "some apparent exceptions to this rule," that is to say, that there are some perfect insulators that show a high inductive discharge; but if I have succeeded in giving a correct idea of what constitutes perfect insulation, this is simply impossible, and indubitably proves that such materials are far from being perfect insulators; indeed, it is a contradiction in terms to designate any material perfect, or even passably good, which lacks, or possesses in an indifferent degree, the quality which stamps its perfectibility.

But the conclusion of the sentence goes on to show that these "apparent exceptions" are the results of extraneous and accidental circumstances affecting the experiments on insulation, and, it might have been added, of inexperience, indifference, clumsiness, and, on the part of the manufacturers, defective workmanship. The best of materials may be to a certain extent nullified, and shorn of some of their most excellent qualities. The insulation of submarine cables, above all things, requires the most perfect and finished workmanship, and until this is comprehended in its fullest import, and acted upon by manufacturers, we shall never reach that perfection of insulation which it is so desirable to attain.

In conclusion, if our doctrine be established, the text stands wrong in the subjunctive mood. "The more perfect the insulating property of the material is, the less is its inductive capacity," without an exception, and, of course, the two properties are not, and cannot be, independent.

AMICUS.

ALLAN'S AUTOMATIC TELEGRAPH.

To the Editor of THE ELECTRICIAN.

SIR,—I was much struck with your observations in THE ELECTRICIAN of the 4th ult., on the subject of "Automatic Telegraph Instruments." An automatic system being evidently the goal and aim of all in the art of telegraphy. Being curious, however, in such matters, I like to investigate for myself, and from a careful study of the system and inventions you especially refer to (Mr. Allan's) at the International Exhibition, I am free to say that, notwithstanding the unreserved eulogy you give to Allan's Automatic Telegraph, not only as a great stride in advance, as compared with others past and present, but also as the *ne plus ultra* of the display in the Telegraphic Department of the present International Show of 1862, you fall far short of telling us all their beauties and peculiarities, and furthermore, the useful results that may be expected from their general adoption.

Allow me, therefore, more minutely to explain some of the details of this really automatic system.

The first instrument in the series, the punching machine, to compose the message, "*à la* Jacquard," by perforating a ribbon of paper, is peculiarly ingenious, very simple in principle, and a great economy of time; one motion of the hand, by the depression of a key, stamps out a whole letter, instead of four or five movements, as is required by any other method yet proposed. There is no hurry scurry, yet much higher speed is obtained in the work done.

The ribbon of perforated paper. The message so prepared is then placed in the transmittor, or machine to manipulate the electric signals to be sent, in lieu of hand labour as at present, and which is of course limited in speed to the skill of the operator. And here it is we have the real automatic action, as each perforation of the ribbon is drawn into the machine (by its own action, as will be seen hereafter), the magnets therein become alternately active, and at each movement of the keeper, between the alternately charged magnets, a lever connected therewith, acts on and winds up a coil spring little by little at each stroke; which spring, in consequence of the power so stored therein, is in its turn always running down, and so giving motion to a small drum, which draws through the perforated ribbon of paper. The perforated ribbon acts mechanically, like a rack upon a small pinion, in the machine, where electrical contact is made at each motion given to the pinion wheel, and thus it regulates and annotates the time between the signals sent; so that at the receiving instruments the dots or marks are made in accordance, and fully exactly with the perforations in the Jacquard ribbon in the transmittor, arranged and grouped by the punching machine, in such order as to represent the arbitrary signs of telegraphic letters.

To follow the action of the machine, we find as each perforation on the ribbon is drawn in, it turns the pinion, makes the magnet active, drives the keeper, which with its lever winds up the spring, which drives the feed drum which draws through the paper, when each hole as it arrives not only causes a signal to be sent to the receiving station, but creates that continuous or renewed action which renders the machine itself a complete and perfect automaton, and so it would go on, *ad infinitum*, so long as the string of holes lasted, without any one even looking at it.

The receiving machine is exactly a counterpart, *quoad* its automatic arrangements and action. The feed-drum drawing through fresh paper to receive the embossed marks, from the motion given to the keeper, at each signal sent through the relay. The arrangements in this relay, as regards the removal of the injurious effects of the spark, are most important, rendering the relay more sensitive, and also more permanent and constant in its action. The relay is so combined with the break in the receiving instrument, that contact only is made at the relay, and the breaking of contact in an ingeniously contrived friction break in the machine, where the bad effects of sparks are mechanically overcome by the machine itself. This is a most important part of the apparatus in its probable results, inasmuch as longer circuits can be worked with greater facility, and with less delay, than is now experienced on comparatively short ones. It has been designed, I believe, most especially to overcome many of the practical drawbacks in the working of long submarine circuits, and must be of most essential importance in the more effective working thereof.

By the adoption of a dot alphabet, and so utilizing the reverse currents in producing a marked signal, in lieu of a blind one, there is a gain of 50 per cent. in speed on that alone, as compared with the Morse alphabet now in use, on a given number of signals sent, besides a double or treble extra speed in transmitting signals, by the adoption of mechanical in lieu of manual transmission. Some slight objection may be made to the adoption of the dot alphabet from the hitherto general adoption of the Morse, but the gain is so evident, that the advantages greatly outweigh the mere learning a new alphabet; whilst, also, when circumstances may arise to make it advisable to use the Morse instead of Allan's, a very slight alteration in the punching machine would effect it.

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Taken as a whole, these inventions are the most complete system of automatic, self-acting, labour-saving mechanism that we have seen for many a long day, and taking them in combination with their duties, and appliances of electricity to the telegraph, the annihilation of time and space, they impress one with a feeling of astonishment, if not awe. They are well worth a careful study in every part and combination, not only from the telegraphist, but from the machinest in general, whilst also they seem to meet, in the fullest degree, the present requirements in telegraphing—rapidity, accuracy, and economy. The *sine qua non* in cheap telegraphy.

There are other appliances in electrical science exhibited at Mr. Allan's small space, of fully greater import, if possible, than the foregoing, disclosing great originality and novelty of design, with a boldness of execution that surpasses all else I have yet seen in Class XIII. With your leave, when the spirit moveth, I may again recur to some of these.—I am, sir, your most obedient, INVESTIGATOR.

Kensington, August 16, 1862.

RAILWAY TRAIN SIGNALS.

To the Editor of THE ELECTRICIAN.

SIR,—I am very glad that Mr. Preece has taken the above important subject in hand. I have read his papers with great pleasure, as I trust some of our railway authorities will, to their advantage. I have heard complaints made that the ELECTRICIAN is becoming too learned and theoretical. I hope that the writers in the ELECTRICIAN will express their thoughts, and declare their experience, in a simple and comprehensible language, not abstrusively technical, but in a clear, defined, and popular manner. The importance of telegraphy demands it. The science requires not the officious dictation of professorial chairs, or self-constituted electrical authorities.—Yours, &c.,

ORLANDO.

TELEGRAPHIC ALPHABET.

To the Editor of THE ELECTRICIAN.

SIR,—In ordinary language the different letters of the alphabet recur with very different degrees of frequency. I am engaged in arranging a new telegraphic alphabet, and am desirous of applying the simplest combinations of signals to the commonest letters. I should feel obliged if you, or any of your readers, would inform me where I can procure information of the average respective recurrence of each letter.—Yours obediently,

A. B. C. D.

August 18, 1862.

To the Editor of THE ELECTRICIAN.

SIR,—I am much obliged by your kind answers to my enquiries, and trust I shall not be trespassing too much on your time if I take the liberty of asking one or two more questions on the subject of batteries. In using cast iron with nitric acid for the negative element, the amount of nitrous vapour given off at first is not much, but after some short time the vapour increases suddenly in dense red fumes, and the acid foaming up over the porous jar; does this occur with platinum or carbon negatives? Can this effect be removed by any means when using cast iron for negative poles? is there not some means of rendering iron passive by attaching platinum to it? Can you tell me if this is correct, and if so, what proportion should the platinum bear to the iron. As steel contains a larger proportion of carbon than cast iron, would this be preferable, as steel would then be cheaper than the price charged for carbon poles. I also wish to ask your opinion on a new form of induction coil. I propose to have a considerable length of primary wire, instead of being covered with cotton or silk, to be covered with No. 36 wire covered with cotton, so that it will be insulated with the covering which is on the 36 wire, and the small secondary wire will be wound on the primary instead of cotton, the said primary wire to be wound on a core of small iron wire, the ends of the small secondary wire to be left exposed at each extremity of the primary wire, for receiving the inductive effect from on passing a current through the primary wire, do you think that there would be any effect in the secondary wire? Of course it would not be practicable to put on a great length of primary wire covered with the secondary, but it might be put on in layers, and the whole of the secondary ends collected together, or joined in one continuous length. If I am not troubling you too much, will you give your opinion of its probable effects.—Yours respectfully,

J. COOK.

RAILWAY TELEGRAPHS.

To the Editor of THE ELECTRICIAN.

SIR,—Referring to Mr. Preece's valuable paper on Railway Telegraphs in your last week's number. I trust you will permit me to offer an observation in explanation of a statement calculated to injure the reputation of my "Train Signalling Telegraphs;" your correspondent in speaking of the merits of my instruments in contrast with others, finishes his remarks in rather a depreciatory manner, by saying, "Tyer's instruments moreover, are liable to be affected by atmospheric electricity."

As the subject of signalling trains by telegraphy is at the present time engaging the attention of Railway Managers and Engineers, I cannot allow the above remark to pass unnoticed. I would therefore beg to observe that *all* telegraph instruments are liable to be affected by atmospheric electricity, but special arrangements have been adopted in the construction of my instruments to reduce this liability to a minimum, and I can instance several occasions when my instruments have exhibited correct signals during storms, whilst the ordinary needle system has been either destroyed, or reverse signals shown on the dials, caused by atmospheric electricity. With regard to the comparative cost of the two systems I remark that mine is generally about one half that of Clark's. Apologizing for thus trespassing upon your attention,—I am, yours &c.

EDWD. TYER.

15, *Old Jewry Chambers, E.C.* 19*th August*, 1862.

Miscellanea.

TELEGRAPHIC IMMUNITY IN WARFARE.—We quote the following from an American journal:—"An order of the War Department states that the telegraph lines being required for military purposes, all persons actually employed in their construction and operation at the date of the order calling for 300,000 men, be exempt from military duty so long as they remain in such service."

THE TELEGRAPH IN FRANCE.—It may be remembered that a reduced and uniform tariff for telegraphic despatches in the interior of France came into operation on the 1st of January last. During the three months following that date, 124,797 more than in the same period of 1861 were sent, being an increase of 80 per cent.; the additional receipts for that period in 1862 was 47,408f. or 8 per cent. over the corresponding period of the previous year. The increase in international communication for the same months was 10,206 despatches, producing 27,669f. As no alteration in the tariff for foreign despatches took place, that augmentation must be attributed to the continued development of the relations of France with foreign nations.—*The Times.*

DEATH BY LIGHTNING.—On Wednesday, the 27th ult., some labourers on the farm of Mr. Richardson, at Elvington, in the East Riding of Yorkshire, were engaged on the clover harvest, when a thunderstorm came on. A man named Johnson, who was forking, was struck down by a flash of lightning, which also struck another man named Wills, knocking him off the load of hay, and setting fire to the hay and cart. The horses were also knocked down, but were soon up and away with the burning load. Johnson now recovered, but found his companion Wills a blackened corpse. The poor man had been struck on the head, which was split open, and the flesh was torn from one arm and a portion of the foot. His clothes and boots were completely burnt up.

To Correspondents.

*** We are compelled to leave out this week the continuation of Mr. Preece's valuable paper on "Railway Telegraphs" in consequence of the non-execution of a woodcut.

ONE WHO WISHES TO KNOW.—By no force or persuasion can we obtain the information you require, and as one of the public you have a right to be furnished with the details of the mode and manner in which the public money has been expended. Sir Morton Peto endeavoured to have the "further" correspondence, &c., placed before the public, and we trust that next session other patriotic and influential members will follow his example. The Malta Tripoli and Alexandria cable is public property. It has cost an enormous sum of money, yet the public are kept in blissful ignorance of its condition, or the revenue it yields. Why is it so? One might have thought that, for the encouragement of telegraphy, the authorities interested would have been glad to afford every information in their power to strengthen the gradual increase of public confidence in ocean telegraphy.

D. TUNKS.—We shall be able in a few days to furnish you with specimens of insulated wires and submarine cables for the interesting purpose for which they are required.

L. T.—We believe that Her Majesty's Government has decided not to grant pecuniary assistance to any submarine telegraph company for the present.

PATENT.—Read article on "Iron Covered Cables" in present number. Not a single recommendation contained in the Government Committee's Report, has been adopted as far as we have been able to ascertain.

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The Electrician.

Vol. II. No. 43.—August 29, 1862.

CONTENTS:

	PAGE		PAGE
J. L. Ricardo, Esq., M.P.	193	Moral Causes	200
Telegraphic Delays	194	Iron Covered Cables	201
On the Periods Occupied in Charging Different Lengths of Telegraph Wire, &c.	194	Telegraphic Delays	202
On Railway Telegraphs	195	Prices Current of Insulating Materials	202
Some Considerations on the Principles of Electrical Conduction and Accumulation	197	The Earnings of Telegraph Companies	203
The Student	199	Telegraphic News	203
		Correspondence	203
		Miscellanea	204
		To Correspondents	204

J. L. RICARDO, ESQ., M.P.

Our readers will have heard with regret of the decease of John Lewis Ricardo, Esq., M.P., which took place on Wednesday the 20th inst., at his residence in Lowndes Square.

Whatever difference of opinion may exist as to whom is due the practical adaptation of electricity to the purposes of telegraphy, there can be no question that Mr. Ricardo it was who first succeeded in establishing the electric telegraph on a firm and successful footing in this country. As is invariably the case with all undertakings containing any element of scientific novelty, there were difficulties raised, both real and imaginary, and objections made, by the sceptical as well as by the timid, at the outset of the Electric Telegraph Company, enough to discourage any but the most undaunted, far-sighted, and energetic; such a man Mr. Ricardo undoubtedly proved himself to be, by the manner in which he grappled with and overcame all these impediments, and eventually established the Telegraph Company on a firm basis, as an important commercial undertaking of the utmost possible value to the country at large.

That rival companies have since been established, and vast improvements made in every department of telegraphy, does not, in our opinion, detract one iota from the credit of him, to whose sagacity and perseverance is due the "planting," if we may so term it, of the parent Company in this country, since it is impossible to say for how long a period the general use of this invaluable invention might have been delayed, if Mr. Ricardo had been less persevering or less determined in carrying out the enterprise in question.* But he not only *founded* the Electric Telegraph Company, he watched over it in his capacity of Chairman, with untiring care for upwards of ten years, seizing upon every opportunity of developing its resources, and of rendering it of greater benefit to the civilized world; and we believe we are safe in asserting that no public company ever received from its Chairman more constant and unwearied attention than was bestowed by Mr. Ricardo upon the affairs of the Electric and International Telegraph Company. As a commercial undertaking, he raised it to considerable eminence; and such was the appreciation, by the shareholders, of his talented administration of their affairs, and such the attachment and respect felt by the officers and employés of the Company, that, on his retirement from the chair, they presented to him the very valuable addition to his Library of upwards of 1,000 volumes, the selection of which was, with great delicacy and discretion, left to himself.

Among the improvements introduced in the system of the Telegraph Company by him, may be mentioned the plan of franks, or franked message papers, by which much time and trouble were saved to the public; and also the employment of female clerks, an innovation of considerable importance in a social point of view.

* That this opinion is shared by others is evident by the graceful tribute of respect which was paid to the memory of Mr. Ricardo on the day of his funeral, by the Electric and International, the British, and the London District Telegraph Companies, who, on that occasion, partially closed all their offices in the metropolis and throughout the kingdom, while at Southampton, and other sea-port stations, the Company's flag was hoisted half-mast high.

Mr. Ricardo was connected with many other important and useful undertakings. He was Chairman of the North Staffordshire Railway from its first construction to the time of his decease, he was also Chairman of the Norwegian Trunk Railway, for the construction of which, for the Norwegian Government, he had contracted jointly with Sir Morton Peto and Mr. Brassey. He was at one time Chairman of the Metropolitan Railway, and had been for many years a Director of the London and Westminster Bank.

The great administrative powers, and general aptitude for business, which Mr. Ricardo displayed in his management of these various undertakings, was the more remarkable from the circumstance of his not having been originally educated, or trained, with a view to his becoming a man of business. It is, perhaps, scarcely within our province to enter upon any particulars of his early life, but we may be allowed to remind those of our readers, to whom the deceased gentleman was only known as a man of distinction in the political and commercial world, that Mr. Ricardo was once pre-eminent in every athletic sport, and every daring amusement, of a period when high spirit showed itself in ways which would scarcely be appreciated or understood in these more sober times; and some of those with whom he was associated in business of late years will not have failed to perceive in the bold policy which Mr. Ricardo adopted on many trying occasions, a trace of that same dashing courage and fearlessness which prompted him on one occasion to perform the daring feat of riding a spirited horse, bare-backed, up a staircase and into a dining-room, at Aylesbury.

No thoughts of business had then been entertained by him. He had chosen the army for his profession, and was, if we recollect rightly, actually *Gazetted* to a commission in the Life Guards, when the death of his father, Mr. Jacob Ricardo, entirely changed his intended career, and he was induced to take up and carry out several of the large financial operations in which that gentleman had been engaged, amongst which was the Spanish Loan. From that time he appears to have become gradually engrossed with political and commercial affairs. He entered Parliament in 1841, as the representative of the important borough of Stoke-upon-Trent, and retained his seat through several general elections, up to the time of his death. He soon distinguished himself in Parliament as an advanced Liberal, and one of the staunchest advocates for Free Trade: taking an important part in the great battle for the repeal of the Corn Laws, and being chiefly instrumental in obtaining the repeal of the Navigation Laws.* It was also, we believe, greatly owing to his exertions that the Stade Tolls, a vexatious duty imposed by Hanover upon shipping ascending the Elbe, were recently abolished; and we remember to have seen, during the session just closed, a notice of motion by him in respect to a revision of the Patent Laws, an important matter to which he had, on a former occasion, given much attention.

Mr. Ricardo was a man of refined taste and a great lover of the arts. He possessed a particularly fine collection of water-colour drawings, and was himself no mean artist, having a remarkable talent for rapid and vigorous sketching.

The illness, which has ended so fatally, commenced in February last, but it was only within a week of his decease that any alarming symptoms had manifested themselves. He had for many years been a terrible sufferer from gout, and it was often cause for surprise to those associated with him, that he was enabled to attend with so little remission, to the important interests entrusted to his management.

Mr. Ricardo will be mourned by a large circle of friends and acquaintances, and his death cannot fail to be regarded, to some extent, as a public loss. He was only in his 51st year; but his life, if not long, was an active and a useful one.

* Mr. Ricardo was the author of a work entitled, "The History and Anatomy of the Navigation Laws."

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TELEGRAPHIC DELAYS.

We reproduce this week a portion of an article which has appeared in the *Daily Telegraph*, and which, from a number of communications which have followed, appears to express the opinions and impressions of at least a large section of the public. The charge of negligence and of inefficient arrangement which has been brought against more than one of our telegraph companies, has not at the present moment been even partially refuted. We cannot but think, however, that in many of the cases which have been brought forward, the delay has occurred under exceptional and perhaps unavoidable circumstances. The numerous contingencies which may occasionally arise to prevent the immediate transmission of a message by the telegraph wires, cannot be understood by the general public. But why should not the telegraph official in these cases take the public into his confidence, frankly and civilly explaining the difficulty, and pointing out that the inconvenience and loss is not on the side of the public only? If this had been done should we have heard of these complaints? The public is seldom unreasonable, save when it is treated in an unreasonable, off-hand, and apparently careless manner. We fear that there are grounds for the assertion that the "management of a delicate and beautiful instrument," and the representation of the telegraph company before the public, are confided to incompetent hands. The absolute necessity of improvement in this respect is sufficiently obvious.

We confidently hope that the facts brought forward by "A Victim to Telegrams," in a letter to the *Times*, which we also reproduce, will not be traced to the defective arrangements of the English company. In a former instance the delay was found to have occurred in the Italian telegraph stations, and we were led to expect that ample measures had been taken to obviate any future inconvenience from this cause. In the interest of telegraphic enterprise, the fresh complaints which have been made public should receive full investigation.

ON THE PERIODS OCCUPIED IN CHARGING DIFFERENT LENGTHS OF TELEGRAPH WIRE, WHEN THEIR DISTANT ENDS ARE TO EARTH.

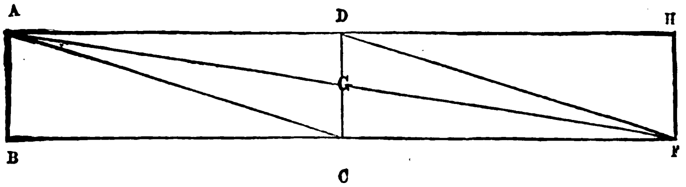
BY RICHARD LAMING, M.R.C.S.

AUTHOR OF "STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY."

[Continued from p. 185.]

With his usual liberality, on which I am presuming to draw rather freely, the Editor of The Electrician, after telling us that the ratio of the squares of the length for resistances in electro-telegraph wires is not in accordance with his conclusions, gives us a geometrical case for examination, with this intimation:—"If the conclusion we arrive at from the following considerations can be disproved, we need scarcely say that we shall be ready to modify our views." Some antecedent remarks give me reason to suppose it is to myself that that intimation is chiefly directed; I shall, therefore, examine the case submitted, in the confident expectation of making the Editor a convert to the law that he does me the honour to suppose I have already succeeded in confirming to the satisfaction of many of his readers.

In the 182nd page it is said, "taking a single and a double length of wire represented by B C and B F in the following figure, we have it admitted that the time of charging, when the wires are insulated from earth, will be in the ratio of the squares of the lengths. To communicate the charge represented by the rectangle A B F H, four times the period of time necessary to communicate the charge A B C D will be required. Now it follows that if we could communicate to B C a charge represented by the triangle A B C, and to C F a charge represented by D C F, we should preserve the same ratio in the periods of charge, the equal rectangles being halved and the distribution of the charg in each section of wire being unaltered."



So far I can grant what the argument requires, during the full import of the conditional "if;" but I apprehend that what follows will be rejected as untenable after a moment's criticism. "If we can charge the length B C, when connected to earth at C, in one unit of time; we may conclude, therefore, that four units of time would be occupied in obtaining, upon the double length B F a distribution of electricity *represented by the triangles* A B C *and* D C F." With respect to this it may suffice simply to point out that one of the two following things must be true,—either, to get the distribution of charge as represented, C as well as F remain connected to earth, in which case they are not a double length of wire, but two single and separate lengths; or, being made a double length of wire by insulation at C, then the two triangles A B C and D E F no longer represent the distribution of its charge, the single triangle A B F having assumed their office. And in either case the argument fails, for in the former the triangle D G F ought not to be removed to the place of A G C, being wanted where it is, and in the latter there would be no D G F to be removed, nor place to move it into if it had any existence.

I hope this will settle the question in the mind of the Editor, and induce him to admit that the ratio of the squares of the lengths is the law of *resistances*. But why should any one set about attempting to disprove an electrical doctrine by a geometry that is not even alleged to have its counterpart in practice, when it is possible to examine the same doctrine with mathematical accuracy and equal simplicity by geometry representing a natural state of things? Why has the Editor, in this instance, founded his argument upon the geometrical conditions of two separate wires as though they could be the same things as the well-known conditions of a wire of double length? It is this practice that I complain of as having a tendency to sacrifice physical truths to sophistries, couched under the alluring form of mathematical exactitudes.

But after all, those who object to the ratio of the squares as a law of practice may be nearer the truth than they have a right to infer from anything that has been written upon the subject; for my own part, I see good cause not to question the absolute exactitude of the experiments of the Messrs. Bright, by which they arrived at the ratio of 3 : 1. To say this while I am at the same time insisting upon the truth of the law of the squares, will appear paradoxical; but it has to be recollected that experiments are usually made under circumstances that introduce another element requiring to be taken into calculation; for in calculating resistances we have thought only of the wires themselves, not of their surroundings. As the theory of definite electrical attraction is true, so surely cannot a particle of electricity pass along the inner conductor of an interred or a submerged cable without a corresponding quantity leaving its surface to ascend to the surface of the earth or water, returning again on the particle being withdrawn. Hence what is known in practice as *retardation*, comes by theory to be added to resistance, or inertia; and that addition is by no means an insignificant item for prolonging the time occupied in charging the wire, as we learn when we compare the charging periods of aëreal lines with those of cables, remembering that in the former, when the weather is frosty, or the air otherwise made dry, the air thereby becoming almost a perfect nonconductor, we have only the resistance of the wire as a hindrance, while in the case of the cable the hindrance always includes retardation as well. And as in the absence of

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retardation the law of the squares would dominate, therefore on its magnitude, when present, must depend how far that law shall be departed from. But as its magnitude will not increase with the length of the wire, we have in the cases of all lengths some certain constant virtue to be added to the numbers representing the resistances; if, in comparing a double and a single length of wire, we assume the retardation to be one half as great a hindrance as the resistance of the shorter wire, then we shall have for the totals of retardation and resistance the ratio of $\frac{1}{2}+1=1\frac{1}{2}:\frac{1}{2}+4=4\frac{1}{2}$, or 1 : 3; and, in the case of the same comparative lengths, this departure from the law of the squares will be more important as the retardation is more in excess of the resistance, that is, as the interments are deeper.

The practical conclusion with respect to length, therefore, is this:—the periods occupied, under given circumstances, in charging different lengths of telegraph cables, when their distant ends are to earth, vary in a ratio that is less rapid than the squares of the lengths, and that approaches to that ratio more closely as the lengths become greater; because the periods are determined by two different hindrances, 1st, *resistance* to the passage of the charge along the wires, or *inertia*, increasing as the squares of the lengths, and *retardation*, which is the resistance or inertia opposed to the passage of induced charge away from the outer surfaces of the wires, and that for all lengths is the same in amount.

This may be represented by the formula

$$T = L^2 + A$$

in which T is the time of charging, L the length of wire, and A a constant valve, represented in the case of *unmailed* marine cables by the mean depth of water above them.

At the 181st page it is remarked of certain arbitrary mathematical laws, "we can readily conceive that they may possibly be found susceptible of improvement so far as they express general conceptions of physical agency;" we shall think their improvement more than *possible* if we reflect upon the mass of confusion in which the law of charge has been inextricably hidden, despite its mathematical demonstration, until the present moment, when the discovery of the physical *modus operandi* has supplied the necessary data. We may be satisfied that Professor W. Thompson, in arriving at the squares of the lengths, did all that an accomplished mathematician could do, with such data as were then at his command.

Having thus alluded to the editorial article headed "Ohm's Laws," I will, without commencing anew, append here a few further comments upon it. Is it claimed on behalf of *mathematicians only* to be qualified "to impugn the accuracy of the fundamental laws of dynamic electrical force propounded and established by Professor Ohm?" If so, I presume the claim will be extended no farther than to the mathematical superstructure, to which, indeed, mathematicians generally confine their criticism; for it will hardly be disallowed to electricians to be competent judges of the physical basis on which the laws are erected. And the time for impugning that basis is not, and never can be, "past," so long as the laws remain unapplied, and therefore unproved, in any particular; in proof of which it would not be difficult to point to cases wherein they must inevitably fail if the attempt were made to prove them universally applicable. The following will perhaps afford an example:—

Let a galvanometer be constructed with but few turns of very fine wire, and made to connect a large couple of zinc and copper plates, placed in a cell far distant from each other. Pour water into the cell until the lower edges of the plates are immersed, and continue adding the fluid so long as the galvanometer deflection shows any increase, always, on its becoming inconveniently great, separating the plates further asunder. A point of immersion will probably be arrived at, beyond which, at a given distance of the plates, no further addition of water, though it should increase the immersion of the plates a hundredfold, can increase the deflection; but if the law and fundamental formula of Ohm be true no such point should be attainable, for every increase of the fluid area between the plates should be attended by decrease of resistance and consequent augmentation of galvanometer indication, which augmentation, in the case I have supposed, ought to be enormously great.

I have not tried this experiment, and, therefore, will not offer an opinion of the distances and dimensions of parts that would be most suitable, but with a few preliminary trials all such details could be properly adjusted; and I believe the result of the observation would be to deny, in a very palpable manner, the applicability of Ohm's law to the circumstances of this particular case. The distance of the plates should, from the beginning, be very great, and their dimensions considerable; so that by their final immersion the total resistance, that is the sum of $R+r$, may be reduced to a small fraction of what it had been when the maximum effect was established; instead of its being lessened by the abstraction merely of some insignificant quantity, as in the two cases cited on page 181, and which could not have been better selected had the object been, while admitting the discrepancies between law and fact, to make them too small to be observed. The case I have adduced is one exactly of like kind, but selected to *show* discrepancy; and if we represent it by the formula

$$I=\frac{E}{50+2} \text{ reduced to } I=\frac{E}{25+2}$$

by the requirements of the non-effective immersion of the plates, the predicted *no difference* in the deflection of the galvanometer would be significant enough; but if it were needful the 25 might be farther reduced, to less even than 1, by only having the plates large enough.

On theoretical considerations alone, it is impossible for Ohm's r to have its value determined by dividing the length of a wire by its sectional area, while it is made up of two elements that do not vary in the same ratio. The laws of that able mathematician are a familiar and easy substitute for the truth, which, in many cases, they represent with sufficient accuracy for practical purposes; but, good as they are, the truth itself is better, as it must be applicable to all cases without exception, and with an exactitude to be found in nothing that is artificial; that Ohm's laws are artificial cannot well be doubted.

ON RAILWAY TELEGRAPHS.

BY W. H. PREECE, ASSOC. INST. C.E.

[Continued from page 174].

MR. EDWIN CLARK (M. Inst. C.E.) in an interesting report addressed to the London and North Western Railway Company, upon improvements in their telegraphic system, remarked—

"The following conditions should, I think, be insisted upon in any application of a telegraph to railway purposes:—

"1st. The machinery employed must be of the most simple and evident description, not liable to disarrangement; and easily repaired.

"2nd. The signals must be simple and few, and so distinctiv that no mistake can occur.

"3rd. No dependence must be necessarily placed on the memory of the person in charge, and the signals should be permanent, and not temporary, or liable to misconstruction or neglect from the absence of the attendant.

"Lastly. And, more particularly, no accident should be actually caused by the derangement of the apparatus, or the absence of the signalman, but such absence or derangement should merely cause the delay of a train."

His own instrument meets these requirements more closely than any other; but still something more is required to overcome prejudice, and instil confidence in the use of electrical signal apparatus.

It must be observed that, in each of the systems I have de-

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scribed, the two signals, denoting such opposite and different meanings—the one the element of safety, the other the source of danger, are not sufficiently distinct in their opposite indications. On the line, the semaphore arm, at one time elevated and another time depressed, is clear and unmistakable in either position. So with a disk at one time visible, at the next moment obscured, no error can occur. But a slight thin index, in a dark dismal hut, with only a movement of an inch or two from one side to the other, whether it be momentary or permanent in its deflection, is so liable to misconstruction, and to be mistaken by a hasty glance, that any improvement upon its recording system must be considered a vast improvement on existing systems.

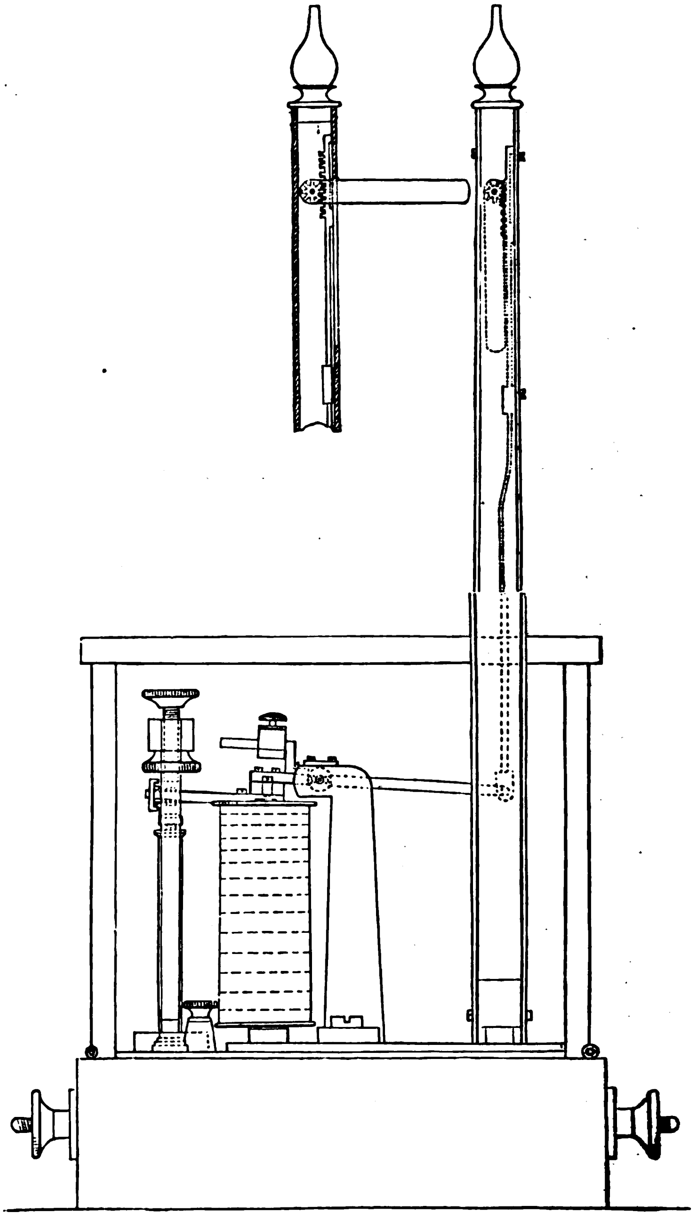
Mr. Spagnioletti, of the Great Western Railway Company, has introduced an ingenious modification of the needle instrument, which has considerably removed that objection. The front of the dial has a slot in it, about one inch and a half long by one inch wide, which allows two signals to be visible. These signals consist of bold printed words—the one "line clear," the other "train on line." The former is printed on a white, the latter on a red ground. They are so attached to the needle that when it is deflected to the right "line clear" is shown, and when to the left "train on line." When no current flows, neither are fully visible. The instrument is used on the block principle.

Although this is a considerable improvement upon existing needle instruments, still it cannot be said to overcome all the objections to that system. The needle is still liable to reversal. One instrument may show "line clear," whilst the other signals "train on line." But there are other disadvantages to this, as well as to other existing systems These signals are so dissimilar to those used out of doors, that the signalmen have to master and comprehend two different methods of signalling—the one line signals, to regulate the trains; the other, electric signals, to regulate those of the line. They necessitate the comprehension of two different and distinct systems, which, with uneducated men is always a matter of difficulty, and generally resulting in confusion in moments of danger, and difficulty at the very moment when clearness of mind and confidence are essential. Uniformity is wanting. I have endeavoured to obviate these disadvantages by making an instrument which is an exact counterpart, on a small scale, of the signal used on the line, and which shall be worked in precisely a similar manner. If a semaphore be used on the line then I employ a miniature semaphore, whose arm is raised and lowered by electrical agency. If a disc be employed, then I use a disc, whose half revolutions are effected by the same power. Whatever signal be used on the line the same is employed indoors. A bold, unmistakable signal is thus obtained, whose opposite meanings cannot be misread; confusion is avoided, not only by their distinctness, but by their assimilation to those of the line. Confidence is assured by their perfect comprehension by the signalmen, and by their inability to cause misunderstanding.

The accompanying figure (fig. 6), explains the construction of the semaphore.

It is needless here to enter into any elaborate description of the construction and working of this instrument. It is fully described in the published specification. A telegraphist will perceive it at once. A railway man will comprehend it at a single inspection. The attraction of the armature raises the semaphore in the figure shown, but it can be so arranged by the simple reversal of the rack and pinion movement, that the attraction of the armature shall lower the arm, and that the current shall always keep the signal at clear. There is an adjustment weight which can be so regulated that the most delicate current can lower the arm, while it can be worked up to any power. It thus can be operated at any distance. It also has this peculiarity, which renders it distinct from every other system, and that is, that it registers its own signals. The armature, in lowering or raising the arms, at the same time sends a current back to the other station, which tells the signalman there that his signal has been properly made. This is effected by an index on the bell, which shows "signal off" in its normal position, and "signal on" when the semaphore is raised. It is evident that the same movement which lowers the arm could, if necessary, revolve a disc. It will

Fig. 6.



be readily seen how closely and completely this instrument meets all the requirements of Mr. Clark's conditions. The machinery employed is of the most simple character, almost incapable of derangement, and if deranged, reparable even by the most stupid and uneducated pointsman. The signals are unmistakable; indeed, it is evident that if a system of signalling is found sufficient to work the trains by manual agency, that same system must be equally efficient to work the signals when manipulated by electrical agency. The derangement of the instrument cannot produce accident. It can only cause delay. It is, indeed, in many respects a distant signal, completely under control, practically within sight, and readily worked.

The manner in which a tunnel or section of line would be worked is as seen in fig. 7.

A train has just proceeded from A to B. A signals "train in" on the bell. B replies by raising the semaphore at A, and he maintains it in that position until the train arrives out, when he

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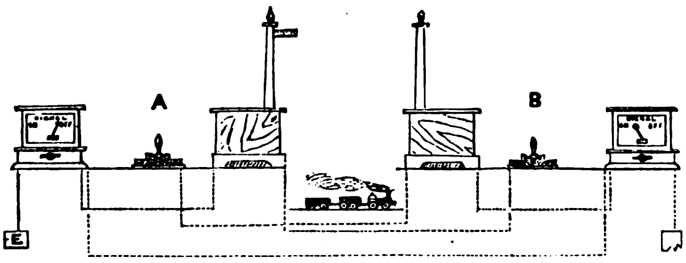
lowers it again. While the semaphore is raised no second train can be admitted. The index on the bell at B shows the condition of the semaphore at A, so that the signalman has a perfect cognizance what he is doing. It will be perceived that this is

Fig. 7.



worked precisely as if it were a distant signal. The bell, like the whistle of the engine, gives warning of the approach of a train; the key, like the switch handle, raises the signal; the indicator, like a signal within view, shows that it has acted properly. Everything is within control of the signalman. If an accident occurs to the wires, either from an accident to the train or by the breaking of the wires, the danger signal is shown at once on both sides; everything is stopped and security obtained.

This instrument has been in use since March last, in working the trains on the London and South-Western Railway, on the incline between the Queen-street and St. David's stations, Exeter. It has never once failed. It has not even required attention. The out-of-door signals, on the contrary, have received frequent attention, and the speaking needle telegraph, between the same points, has been demagnetized and disordered on more than one occasion.

It is not presumed that this instrument will meet all the requirements of the railway world. It avoids many of the objections of the existing systems. It may introduce others beyond the author's cognizance. Still it is believed to be a step in the right direction, and its uniformity with existing signals, its simplicity and cheapness, entitles it to serious consideration. There will always be prejudice to the use of electricity, until that mysterious power is more fully comprehended. It may not be the instrument, *par excellence*, for railway purposes, but it is believed to be the nearest approach to it yet introduced.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 183.]

To continue the subject it will now be necessary to make use of the term "tension," a term which I have hitherto purposely avoided, on account of the widely varying sense in which it has been employed by different electricians, whilst few have attempted to define the exact sense in which they do use it. Before, therefore, I endeavour to give it a definition, or attempt to explain the sense in which I shall employ the term, it may be well to review its application hitherto.

According to Sir W. S. Harris, "tension" is proportional to what I have termed the "density," a term which I have used to denote simply the proportional quantity of electricity on a given area, or $\frac{Q}{S}$. Thus, he says, "*Tension* denotes the elastic force of a given quantity accumulated in a given space, and is, therefore, directly as the density of the stratum; and this, I apprehend, should be really the true sense of the term, tension, in electricity, on the hypothesis that electricity is an elastic fluid. It is, accordingly, so accepted by many profound writers in physics."*

And again:—"If we for a moment imagine the unknown cause of electricity to be a peculiar subtle elastic fluid capable of compression, then, similarly, twice the quantity upon a given area will have twice the re-active force; that is to say, its "tension" will be doubled; so that in this sense the "electrical tension" will be directly as the quantity of the accumulation on the same area."*

There is, perhaps, no absolute error in thus applying the word; but it is generally used now in a very different sense, being not merely proportional to the density, but only so when certain other conditions, not mentioned by Sir W. S. Harris, and on which it is also dependent, remain constantly the same.

Professor Faraday does not often employ the word, and then only in a sense apparently implying a higher degree of electrical action generally, but without any distinct definition of its meaning. Thus he says:—

"That ordinary electricity is discharged by points with facility through air; that it is widely transmitted through highly rarified air; and also through heated air, as, for instance, a flame; is due to its high *tension*."†

And, again, in speaking of magneto electricity, he observes:—"The attractions and repulsions due to the *tension* of ordinary electricity have been well observed with that evolved by magneto-electric induction."‡.

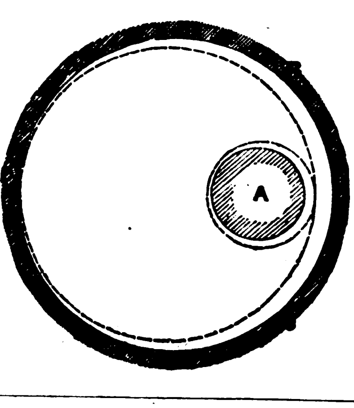
And, in speaking of the effects of thermo electricity:—"The attractions and repulsions due to a *certain degree of tension* have not been observed."§

Professor Faraday also applies the term to the state of the particles of the dielectric between two charged surfaces, thus he says:—"Discharge probably occurs, not when all the particles have obtained to *a certain degree of tension*, but when that particle which is most affected has been exalted to the subverting or turning point."‖

And again:—"Hence, *tension* or *intensity* may, according to the theory, be considered as represented by the particular condition of the particles, or the amount in them, or forced variation from their normal state."

The application of the term in the three first quotations from "Researches" would not be far out of place, even if we assigned to it the same meaning as that in which I shall attempt to show that it is now most generally employed; but, with regard to the latter quotation, however well the word may describe the constrained state of the dielectric, it would be contrary to the sense in which it is now employed. That the electricity on a charged conductor will accumulate itself the most at those parts separated by the least inductive resistance from the surrounding surfaces on which the opposite state exists is well known, and has already been pointed out. If we suppose, therefore, such a conductor charged with a given quantity of electricity, and separated at one part from the opposite surface by a much less inductive resistance than at any other part, as represented in fig. 59, then,

Fig. 59.



* Philosophical Transactions for 1834, page 222.

* "Rudimentary Treatise on Galvanism," by Sir W. Snow Harris, page 109.
† "Researches," vol. i. page 78, No. 269.
‡ "Researches," vol. i. page 97, No. 343.
§ "Researches," vol. i. p. 99, No. 349.
‖ "Researches," vol. i. p. 436, No. 1,370.

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undoubtedly, to describe the more exalted state of the charge, and its tendency to discharge, at the more proximate portions of the two surfaces, as compared to the other parts, the word *tension* (as used by Sir W. S. Harris) would not seem at all inappropriate.

And, in the same way, since the dielectric between the most proximate parts of the two oppositely electrified surfaces is not only less in quantity, but sustaining the inductive action of a greater quantity of electricity, the application of the term, "tension," to the state of the dielectric, as used by Professor Faraday, would also seem exceedingly expressive. But, the sense in which the word is now employed is quite different, and is sufficiently important to warrant its use being limited, when applied to electrical phenomena, to this particular meaning, which I shall presently attempt to define. For the present it will be sufficient to observe that, according to this modern acceptance of the term, if the conductor, A, is charged with a certain quantity, and kept in some constant position, as regards the nearest surrounding conducting surface, D B C, the *tension of A to D B C will be the same at every part of A*, however much the density of the electricity on it may vary at different parts by reason of the varying distance between the two surfaces; and, notwithstanding the fact, that if the conductor, A, have its charge continually increased, the discharge between the two surfaces, through the dielectric, will certainly take place at one particular point, viz., that separated from the other surface by the least resistance.

Ohm, in his celebrated mathematical investigation of the voltaic circuit, uses the word "tension" (if the translation may, as I presume it may, be relied on) to denote the *difference* of, what he terms, the *electroscopic force*, immediately on each side of a surface of excitation, or generation. Thus, he says:—"Different bodies which touch each other constantly preserve, at the place of contact, the same difference between their *electroscopic forces*, by virtue of a contrariety proceeding from their nature, which we are accustomed to designate by the expression, *electric tension* or *difference of bodies*."*

And, in another place, he writes:—"Imagine, for instance, a ring everywhere of equal thickness, and homogeneous, having, at any one place, in its whole thickness, one and the same *electrical tension*, *i. e.*, inequality in the electrical state of two surfaces situated close to each other."

In another place he says:—"In a galvanic circuit, consisting of any definite number of prismatic parts, there takes place, in regard to its electrical state at each place of excitation, a sudden transmission from one part to the other, forming *the tension there prevailing*.

The *electroscopic force*† (the difference of which immediately on each side of any surface of separation constitutes the *tension*) he thus specifies:—

"In order to investigate the changes which occur in the electric condition of a body, A, in a perfectly definite manner, this body is each time brought, under similar circumstances, into contact with a second moveable body of invariable electrical condition, called the *electroscope*, and the force with which the electroscope is repelled or attracted by the body, is determined. This force is termed the *electroscopic force* of the body A; and to distinguish whether it is attraction or repulsion, we place before the expression of its measure the sign + in the one case, and − in the other.

The same body, A, may also serve to determine the electroscopic force in various parts of the same body. For this purpose we take the body, A, of very small dimensions, so that when we bring it into contact with the part to be tested of any third body, it may, from its smallness, be regarded as a substitute for this part; then its electroscopic force, measured in the way described, will, when it happens to be different at the various places, make known the relative difference with regard to electricity between these places."

Now, in this, Ohm was evidently simply testifying the *density* at different parts of a conductor. And, indeed, in specifying the meaning of the word, *quantity*, he leaves us no room to doubt that he considered electroscopic force as entirely proportional to density. Thus, he says:—"We shall in future term the sum of the electroscopic actions, referred to the magnitude of the elements—by which, therefore, we have to understand the force multiplied by the magnitude of the space over which it is diffused in the case when the same force prevails at all places in this space—the *quantity of electricity*, without intending to determine anything thereby with respect to the material nature of electricity."

Here, evidently, the "electroscopic action," multiplied by the space over which it is diffused, constitutes the *quantity*. Therefore, the quantity divided by the space $\left(\text{or } \frac{Q}{S}\right)$ constitutes the "*electroscopic action*." Unless, therefore, Ohm intended to convey in the word, "electroscopic *action*," a different meaning to that conveyed in the term "electroscopic *force*," it is evident, according to the above quotation, that both must stand for the same thing as that which I have designated by the term *density, viz.*, $\frac{Q}{S}$.

But, although Ohm here clearly specifies nothing more or less than the density, it will be found that such a meaning *alone* is not sufficient to give the laws he has laid down their proper and full interpretation, and, that, by "electroscopic force," he meant electrical *force* there existing, and causing that accumulation, and which he has taken as being constantly proportional to the density, which is not, however, admissable, without specifying further conditions than he has named. But, moreover, it is necessary for some of his problems that the density should be considered as constantly proportional to the electroscopic force, in order that the electroscopic force, multiplied by the surface, shall always equal the quantity.

Indeed, there is ample evidence in Ohm's paper to show that he did not contemplate, or, at least, has not provided for, the possibility of the density on one portion of a conductor varying without the electrical force tending to cause the accumulation also varying, and *vice versa*. He treats them throughout as one and the same thing. He, in fact, without ever specifying that the conditions for accumulation at each part of a conductor are to be taken as constantly the same, treats them as if they were so. Thus, in speaking of the effect of an insulated body brought into contact with one point of an insulated, but closed, circuit, he treats the effect which that body would produce on the distribution as entirely dependent on its magnitude, as compared to the surface of the conductors forming the circuit, whereas we know that it would depend also on other conditions, *viz.*, the proximity of the surrounding surfaces to the body, and to the conductors forming the circuit; or, in my own language, on the resistance of the inductive circuit. The quantity of electricity which the body would receive, he shows, will be equal to the change which takes place in the electroscopic force at the point of contact, multiplied by the surface of all the conductors of the circuit.* Here, therefore, the *electroscopic force* evidently is treated as representing the quantity on a given area, besides, also, representing the electric force; and this problem would not hold good unless this be allowed.

It is evident that the two meanings ought not thus to be merged into one, for they are entirely distinct, and are evidently not always proportional to one another. Thus, if we had a conductor, B, connected to one side of a source of generation (or, as

* "The Galvanic Circuit Mathematically Investigated," by Dr. G. S. Ohm, Berlin, 1827. Translated from the German by Mr. William Francis, Student in Philosophy in the University of Berlin.—*Scientific Memoirs*, Vol. II., Part vii. and viii., June and July, 1840.

† He terms it sometimes electric force, force of the electricity, electrical state.

* This is given in such a form that it would be unintelligible, if quoted literally, without quoting several pages.—See pp. 418 and 468, vol. ii., "Scientific Memoirs."

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Ohm terms it, "a tension,") the other side of which is connected to the surrounding objects, then, if we touch this conductor with the small body, we should bring off a certain quantity, which, tested by the electroscope, would represent the electroscopic force of that side of the source. If, now, the surrounding objects are brought nearer to the conductor, B, then, if we apply again the same test specified by Ohm, we should obtain a greater electroscopic force. Now, as the other side of the source is connected to the surrounding objects, according to the same test its electroscopic force will be in each case *nil*, and, therefore, we should have the difference of the electroscopic force between the two sides of the source variable; and, consequently, what Ohm terms "the tension" (*i. e.*, in modern language, the electromotive force), would be variable, which is contrary to his own definition of "a tension."

To render some of Ohm's problems correct, therefore, we must take for granted that which he has neglected to specify, and consider that in each case, when he brought the small body, A, into contact with any part of the circuit, that that part was under precisely similar conditions for accumulation, as regards the distance of the surrounding objects, &c. to that of any other part of this circuit, in which case the proportionate quantity brought off by the small body, A, must indicate the proportionate *electrical force tending to produce accumulation under given conditions for accumulation* at that part touched; besides, also, indicating the actual density at that place. Or, in other words, the electrical force at any part touched would always be strictly proportional to the density. And, in continuation of this, we must further concede that, when he speaks of a large body being connected to the circuit at one part, that every minute fraction of its surface shall be under precisely similar conditions for accumulation, as a similar minute fraction of the surface of the conductors of the circuit. With this proviso the term, "*electroscopic force*," employed by Ohm, may be taken as represented most generally now by the term "tension."

In some of the laws of Ohm there would be no difficulty in substituting the one term for the other, such as those which treat of the electric state of a circuit touched at one part to earth. But there are others, relating to an insulated circuit, which have not been at all generally discussed, which requires, as I have said, that the quantity of electricity on a given area shall be always taken as proportionate to the electroscopic force at that spot, so that the term, electroscopic force, in such cases serves to denote two things; first, the electric force tending to produce accumulation; and, secondly, the accumulation itself; or, to use modern language, that the density be always proportioned to the tension, so that both may be represented by *the single term*, "*electroscopic force.*"

The difference between the "electroscopic force" of points immediately on each side of a surface of excitation, or generation, constituting what Ohm terms "the tension there prevailing," is now generally termed the "electro-motive force." Though, even now, the term tension is sometimes used in an almost similar way to that employed by Ohm. Thus, some speak of "the tension of a single cell," the tension of the battery, &c.

I will now quote a few authors to show in what sense the term tension is employed by more modern writers, even when treating of the law established by Ohm, although it is not often defined.

Blavier writes thus in describing the state of a circuit:—"L'etat électrique, aux differents points d'un conducteur, ne peut etre le meme car il n'y aurait aucune cause de mouvement; il varie d'une manire continue pour chaque partie homogène du circuit et constitue *la tension.* Il est evident du reste que, pour chacun des points il reste constant taut que le courant ne change pas d'intensité. Si l'on électrise tout le circuit, en le mettant sur un plateau en communication aver une machine électrique, la tension augmente d'une quantité egale pour tous les points, mais il existe toujours entre eux la même difference de tension."*

* Vide Blavier's "Telegraphie Electrique," page 392.

It is evident, therefore, here "tension" is the "electroscopic force" implied by Ohm. In the same way De La Rive employs sometimes the word "*tension*," and sometimes the term "état electroscopique" indifferently in the same sense, but the quotations comprising them would be too long to give here.*

Gavarret employs the term in the same way, thus he says:—"Dans la théorie générale de l'electricité dynamique telle que Ohm lá conçui et exposée, la force electromotrice qui fait passer le courant a traver une portion quelconque d'un circuit fermé n'est autre chose que la difference algébrique *des tensions*, electriques qui existent a ces extremités. Il resulte de cette maniere d'expliquer la propagation de l'électricité dynamique que:—

"1. Danschaque section d'un circuit électro-dynamique fermé, il y a de l'électricité à l'état de tension.

"2. La difference de tensions correspondent *a deux points quelconques du* conducteur interpolaire est proportionnelle à la resistance que le circuit oppose, entre ces deux points, à la propagation de l'électricité.

"3. La *tension electrique* est la même dans toute l'etendue d'une section transversale quelconque d'un circuit ferme.

"5. A la surface de contact des deux elements actifs du couple il y a une *variation brusque de la tension electrique.*"†

It will be seen, therefore, that the French electricians employ the term tension in almost the same sense as the "electroscopic force" of Ohm, with this difference, that according to their description it is only an electric state or force; and as they specify no test, they give us no reason to believe that they consider, like Ohm, that this force is constantly proportional to the density, or that the *tension*, multiplihd by the space over which it is diffused, shall represent the quantity.

The Student.

THE THEORY OF MAGNETO-ELECTRIC AND ELECTRO-MAGNETIC ACTION.

The relation between electro-magnetic, and magneto-electric effects may be readily understood by supposing a wire conveying an electric current to be surrounded at every part by *magnetic curves* in planes at right angles to the direction of the wire, and diminishing in intensity according to their distance from the latter. We must, however, find some grounds for this assumption, and we may, in the first instance, render evident, the "curved lines of magnetic force" by means of an ordinary bar magnet.

If we lay the magnet upon a table, covering it with a sheet of white paper and sift some fine iron filings over the latter from a muslin bag, it will be found upon gently tapping the table that the filings will arrange themselves round and about the poles of the magnet in a very beautiful manner, forming the magnetic curves in question. It will be seen that these curves are in a direction from one pole of the magnet to the other, and that the force which acts upon, and polarises, the filings decreases gradually from the poles to the centre of the magnet. Now we already know that if we place a wire in a direction at right angles to the magnet, or, by coiling the wire into a helix, cause it repeatedly to intersect the magnetic curves in this direction, a current of electricity is produced in the wire, the intensity of which depends upon the distance of the wire from the magnet and upon the power of the latter. This current we designate as a magneto-electric effect.

The following familiar experiment will therefore give reasonable grounds for assuming that a conducting wire is surrounded by magnetic curves which may be likened to concentric rings surrounding the wire. It will be remembered that if we plunge the wire into iron filings, a portion of the latter will be attracted to the conductor. Let us now place a small bar of soft iron at right angles to the conducting wire; it will be found to become a magnet, and to be traversed by magnetic curves, as in the case of the permanent steel magnet. It is in fact an electro-magnet; the force of which may be increased by coiling the wire into a helix surrounding the soft-iron, and thereby multiplying the effect produced by the proximity of the wire at one point only. We have here an effect of electro-magnetic induction.

* See De La Rive, pp. 34 to 37.
† See Gavarret, Traite d'Electricité, vol. ii., p. 81.

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Again, we may trace this relation between voltaic and magnetic force in the phenomena of Volta electric induction, or in currents induced by the action of a current. A wire conducting a voltaic current being surrounded by an infinity of magnetic curves, or what might be termed a "magnetic atmosphere," it will be seen that another wire, placed parallel with the first, will to a greater or less extent be under the same conditions as when placed at right angles to one of the poles of a magnet. The secondary wire will also be under the same magnetic conditions as the primary, and will become electrically polarised accordingly, giving a temporary current in the same direction as the primary current.

We have seen that in the case of a straight wire conducting a voltaic current, the magnetic curves occur in planes at right angles to the axis of the wire, while in the case of a magnet these curves are in planes which are parallel to the axis of the magnet. If, however, we coil the wire into the form of a helix, the magnetic curves, when a current is passing, will be in planes parallel to the axis of the helix, and the latter will exhibit all the properties of a magnet, placing itself in the direction of the magnetic meridian, and being, like the needle of the galvanometer, deflected by the action of of an external current. The De-la-Rue ring shews very perfectly the magnetic charactor of a conducting wire, instead of a helix or elongated coil, a close coil composed of several turns of insulated wire bound together in the form of a ring, is generally used. The coil is therefore equivalent to a thin piece cut from the extremity of a circular magnet. It is mounted by soldering the extremities of the wire to a small voltaic couple which may be placed in a very light bowl or saucer and floated in a vessel of water. When a small quantity of diluted sulphuric acid is poured into the saucer containing the voltaic elements, the ring will tend to place itself in a plane transverse to that of the magnetic meridian; and if a strong bar magnet be approached to it on either side, the phenomena of attraction and repulsion will be rendered evident. If the pole of the magnet be presented on the side where attraction takes place, the ring will pass over the magnet and come to rest when it reaches the middle or neutral point. If the contrary pole of the magnet be now introduced in the axis of the ring, the latter will move towards that pole which is nearest to it, and will be projected to some distance beyond it, the ring will then move half round, presenting the opposite face to the magnet; and in this position it will be attracted towards its position of equilibrium over the centre of the magnet. This experiment, properly understood, is one of the most instructive in connection with the present subject matter, which gives some clue to the nature of the intricate connection we have observed between the two most wonderful and subtle agencies of nature, electricity and magnetism.

MORAL CAUSES.

MR. G. P. BIDDER AT THE INSTITUTION OF CIVIL ENGINEERS.

Mr. Bidder, President, said, that if the Paper and the discussion had exhibited the subject as one of national importance, it had also shown it to be a branch of the profession, the practice of which, up to the present time, had been signally unsuccessful. Upwards of 9,000 miles of submarine telegraph cable had been laid down, of which not more than 3,000 miles could be said to be in working order; so that there were 6,000 miles which were almost useless. This result showed conclusively, that there was either a lamentable want of knowledge on the subject, or some radical practical error, which should be carefully inquired into, with the view of applying a remedy. The present deplorable state of submarine telegraphy, was endeavoured to be accounted for, in "Blue Books" and other published documents, by reference to causes which practical men could not admit; and the conviction which forced itself upon the minds of unprejudiced persons, was, that the obstacles to success had been more of a moral than of a mechanical nature. The promised report of the Government Commission on Submarine Cables, would soon appear, and he hoped it would give facts, which would either confirm this opinion, or dispel such an impression. It was understood, that the Report would go full into the questions of the methods of insulation and of testing cables. These had been already brought within the province of mathematical certainty, yet the application of the results had not been satisfactory; and patents were even recently taken out, as if for the purpose of adding difficulties to processes which were already sufficiently complex. He was not perhaps, himself without blame in this respect, having been one of those who contributed £160,000, to secure the original patents for electric telegraphy. But patents had proved the curse of telegraphy, for scarcely was the ink of the agreement for the purchase of one patent dry, before another was offered, which was warranted to supersede all that had been previously accomplished; and he had little doubt, that if it were possible to obtain exact statistical returns, it would be found, that the law officers of the Crown had derived more benefits from those patents, than the public, or those to whom they had been granted. He should have considered testing as the last subject on which a patent could be justified, yet some parties had proceeded by injunction, to restrict others from applying such different modes of testing as had been suggested by daily experience; thus endeavouring to retard the progress of scientific knowledge.

The first considerable failure of a submarine cable, was that of the Atlantic Telegraph Company. It would be remembered, that in a discussion at this Institution, several months before the cable was laid, it had been strongly urged, that the cable should be tested during its manufacture, and subsequently, that it should not be laid until it had been tested under water, as nearly as possible under the conditions to which it would be subjected, when it was deposited in the sea. In violation of all these precautions, the cable was laid, with a strong suspicion of its not being in a perfect state; a capital of upwards of £300,000 was sunk, and the cause of electric telegraphy was seriously jeopardised. It must be admitted, that even if the cable had been perfect when it was submerged, there were natural causes in operation which would, probably, have destroyed its conductibility in little more than twelve months; this, however, could not excuse the recklessness with which so large a capital was risked, without adequate precautions. It had been urged, in extenuation, that the expectations of England and America had been so highly raised by the original promoters, that the Directors of the Company found themselves trammelled by engagements and contracts which left them no alternative; but in such case, it was their duty to have pursued the straightforward course of abandoning their responsibility, until the undertaking was placed in such a shape, as to offer every reasonable probability of success.

The last great failure which had excited public attention, was that of the Red Sea Telegraph. It was not for him to judge of the personal considerations, or the moral ingenuity which had been alleged to be at the root of this undertaking; yet he could not help remarking, that if such causes had been at work, they could not have been more adroitly, or more skilfully applied. Before, however, proceeding further, he felt he had a duty to perform to one whose memory would ever be revered in this Institution. It had been stated, that the sanction of the late Mr. Robert Stephenson had been obtained as to the form of the Red Sea cable. This was probable, as he was always ready to give advice, whenever it was asked; but when responsibility was attempted to be fixed upon him, it became necessary to ascertain to what extent his sanction had been given. Did the gentleman who consulted Mr. Stephenson as to the construction of the cable, inform him who was to be the Contractor? Did they communicate to him the conditions of the contract, or the restrictions under which it was to be carried out? If they did not do so, his opinion as to the mere form of a piece of cable, given probably in the free communication of one gentleman to another, and not as a professional opinion, with all the circumstances of the case before him, should not be made use of, to shift the onus of failure from the living to the dead.

The Red Sea line assumed more than ordinary importance, because the country was under engagement to pay to the Company, about £36,000 per annum, as guaranteed interest upon an outlay which, up to the present time, was utterly useless, and which did not appear to afford much hope of ever being otherwise. The history of this undertaking, as far as it had been made public, was given in the Parliamentary Papers, on Telegraphic Communications in the Mediterranean and with India." (1859 and 1860). He would quote from these published documents only; and, without entering into all the minute details, it would suffice to lay before the Meeting the broad facts, whence it would be seen, that moral causes had entered largely into the fate of this unfortunate undertaking.

On the 26th of June, 1858, the following letter was addressed, by Messrs. Glass and Elliott, to the Lords Commissioners of the Treasury:—

"We beg most respectfully to address your Lordships on the subject of the proposed line of telegraph to India, by way of the Red Sea, which project is now under the consideration of your Lordships, at the instance of the Red Sea Telegraph Company.

"That your Lordships may be fully informed of the circumstances which have led to this communication, it becomes necessary to lay before you the following brief history, in connection with the progress of the undertaking, and our connection with the same.

"In the year 1855, application was made to us by Mr. Lionel Gisborne, who represented himself as acting for, and under the authority of Her Majesty's Government, for information to enable him to prepare

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estimates for the carrying out of a telegraphic line to the East; and on his assurance, that we should be placed in a position to tender for the execution of the work, upon his completing certain arrangements with the Turkish Government, we provided the necessary information, accompanied with many specimens of submarine cables, best suited for the contemplated line, with estimates, &c.; upon which Mr. Gisborne proceeded to Constantinople, and obtained the necessary firman from the Sultan, to lay down the line now under consideration. Shortly after his return to this country, these concessions were placed at the disposal of a body of gentlemen, who formed themselves into a company (the Red Sea Telegraph Company,) for the purpose of carrying out the lines, under the concessions obtained by Mr. Gisborne. In the month of August last, the Directors called upon us to assist them with information, and afterwards, to tender, for the execution of the whole, or one-half the line; which we did, and a prospectus was issued, founded on this estimate, but an insufficient amount of capital was subscribed, caused by certain statements appearing in the public newspapers, to the effect that it was impossible to lay a cable in the Red Sea, from its great depth, and other causes.

"In this state of things we suggested the propriety of an application to Her Majesty's Government, to cause a survey to be made, with a view of testing the truth of these statements; this course was adopted, and the 'Cyclops' was ordered on the expedition, and instructions, forwarded, on our suggestion, to the Admiralty, through the Hydrographer, were sent out to the officer in command of the 'Cyclops,' and the result being highly satisfactory, a further attempt was then made by the directors to carry out the line; hence the proposal now under the consideration of your Lordships. The undertaking having thus far proceeded, it was found, that the agreement between Mr. Gisborne and the directors of the Red Sea Telegraph Company had, in the meantime, lapsed by a few days; and on being called upon by the Company to renew the same, he consented, but insisted, as we have been informed, that in addition to the sum of £15,000, agreed to be paid to him in consideration for the concessions, that he should be appointed engineer to the Company, and that the whole of the work should be given to Messrs. Newall and Company, without tender, Messrs. Newall and Company having become interested with him in the concessions; and he was bound to them accordingly.

"The directors have felt themselves constrained, under the peculiar circumstances of the case, to submit to the terms imposed by Mr. Gisborne, and a conditional contract has been entered into with Messrs. Newall and Company, approved by Mr. Gisborne, to carry out the work for the sum of £650,000, or thereabouts. The directors having given us an opportunity of seeing these estimates, we are in a position to inform your Lordships, that we are prepared to execute similar work for 100,000 less than that amount.

"Should your Lordships find, on inquiry, that our statements are correct, we feel sure that your Lordships will not, under such circumstances, sanction the application of public money to this purpose, for the private gains of individuals to the prejudice of the public."

(To be continued.)

IRON COVERED CABLES.

ON THE SPONTANEOUS GENERATION OF HEAT IN IRON-COVERED SUBMARINE CABLES.

BY WM. ALLEN MILLER, F.R.S.

King's College, London, December 3, 1860.

My Lords,—Referring to your letter bearing date October 1, 1860, in which you requested me to examine into the cause of the heating of the electric cable (proposed to be laid down between Rangoon and Singapore) during the process of manufacture, I, in accordance with your instructions, placed myself in communication with Mr. Gisborne who has given me every facility for inspecting the cable during the process of its manufacture, and for conducting the necessary experiments. I have also received full particulars respecting the tests of the electric conductivity of the cable, and of the conditions in which the heating was observed.

From the information thus obtained, and from various experiments of my own, I have been enabled to arrive at a definite conclusion as to the cause of the heating which was observed.

These heating effects appear to have been due, not to any permanent chemical change, either in the composition of the insulationg coating of the gutta-percha, nor in that of the serving of hemp and tar, but were owing simply to the effects of oxydation upon the iron, at the ordinary summer temperature of the air, produced by the moistening of the cable with the water of the river, the slightly brackish nature of which increased the effect.

It appears that the cable, when manufactured, was coiled in tanks where it was at first wholly submerged in water. Gradually, however, the tanks began to leak as the weight of water increased, and eventually the water was drawn off, leaving the mass of the cable thoroughly soaked in water, but nowhere submerged.

From the mode of stowage necessarily adopted, an enormous surface of metal was exposed to the air in a comparatively small compass. The moisture necessary to the oxydation was gradually supplied by the capillary action of the hemp sewing as fast as it evaporated from the metallic surface, under conditions most favourable to the production of oxydation. This oxydation is always attended with a rise of temperature, but under any circumstances the heating is overlooked, as the mass of air around carries off the heat as fast as it is introduced. Here, however, the conditions were exactly such as would be required for its accumulation, viz., a sufficient access of air to promote oxydation, with an effectual prevention of a rapid change of the mass of air; and a speedy rusting of the metal, attended with a considerable rise of temperature throughout the mass, was the unavoidable result. The process of rusting is very slow at the temperatures not exceeding 50°, but it increases rapidly as the external temperature is augmented beyond this point.

In order for the future to avoid any similar heating of the electric cables during their manufacture, it will be sufficient either to avoid wetting the metallic coating at all, during the process of making, or if it be found needful to immerse the cable in water, to take care that it be always afterwards kept entirely submerged.

The oxydation of iron wire coating takes place at temperatures above 50°, but only when both air and moisture have free access to the surface of the metal.

The method of cooling the cable which was resorted to in this instance, by frequently sprinkling it with cold water, although effectual as a temporary expedient, is attended with an increased rusting of the metal; and if it were discontinued during the warm weather it would inevitably lead to a renewal of the heating in a still more rapid degree. I return Mr. Gisborne's reports.—I am, &c.

(Signed) Wm. Allen Miller, M.D.

To the Right Honourable the Lords of the Committee of Privy Council for Trade.

King's College, London, December 12, 1860.

Sir,—I have the honour to acknowledge the receipt of a copy of a letter, dated December 11, 1860, addressed by Sir W. B. O'Shaughnessy to J. Danvers, Esq.

In reply to your request, that I would express my opinion upon the suggestion of Sir William as to the cause of the heating of the electric cable on board the "Victoria" Steamer, I would remark that that gentleman states that he has not had an opportunity of seeing the cable in question.

Had he done so, I think it not improbable that he would have come to the same conclusion upon the subject as myself.

From the experiments which I have made, and the results of which I reported to you in August last, I am able to confirm the statement of Sir W. O'Shaughnessy, that gutta percha under certain circumstances slowly absorbs oxygen, and might even become heated in the process. This oxydation, however, takes place under free contact with the air, is favoured by an elevated temperature, and as I have particularly pointed out, is especially influenced by exposure to light.

If I understand rightly, in the case alluded to by Sir W. O'Shaughnessy the gutta percha cable was entirely unprotected by any outer covering. If so their is no analogy between that case and the present one; for in the cable at present on board the "Victoria" the gutta percha is covered with hemp soaked in tar, and this coating is again covered with iron wire. The gutta percha is therefore in the dark, and in a great measure excluded from the action of the air.

If Sir W. O'Shaughnessy had examined the cable he would have observed,—1st, that there was a considerable oxydation of the iron covering; 2nd, that this oxydation was in great measure confined to the *exposed* surface of the iron wire, and that where the surface of the wire was in contact with the hemp serving it was scarcely rusted. This oxydation of the wire is abundantly sufficient to produce the heating in question.

Remembering also that the oxydability of iron in a moist condition far surpasses that of gutta percha, Sir W. O'Shaughnessy would probably agree with me in thinking that the oxygen of the air would expend itself upon this freely exposed iron, and could not, therefore, reach the deeper and well protected gutta percha. Still more, he would also have seen on examining the gutta percha, that in reality *no such change from oxydation had occurred.*

I satisfied myself on this point, as of course the oxydability of gutta-

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percha itself was, from my own recent experiments, present to my mind.

The remedy suggested by Sir W. O'Shaughnessy, viz,—the immediate coiling of the cable into water with the view of recoiling it on shipboard into water-tight tanks for the voyage, is exactly the same as that which I proposed to yourself as soon as I was informed that the heating on shipboard had occurred. There is no doubt that it is the true remedy, and that it would be perfectly effectual.

I understand, however, owing to the delay which would be needful in order to enable suitable tanks to be constructed, that such a course would entail the loss of the present season for laying the cable, and that with a view to attempt to obviate this great inconvenience and expense, it is proposed to uncoil the cable, tar it and recoil it.

I have considerable doubt as to the ultimate success of this expedient, but I see no objection to the trial of this *as an experiment*, provided that the freshly coiled cable be exposed for ten days or a fortnight to a careful series of tests, with the view of detecting immediately any rise of temperature should it occur when the cable is duly recoiled into the hold. Even should the process fail in preventing the heating, the loss incurred would be limited to the expense of tarring and recoiling.

If, however, the temperature be still found to rise after the tar has been applied, the sailing of the ship should be stopped at all hazards. The cable, in such a case, must be recoiled into water, and kept there until vessels with suitable water-tight tanks for its conveyance have been prepared.—I have, &c. (Signed) Wm. Allen Miller.

To Captain Galton, F.R.S.

Note or Appendix to Dr. Miller's Report on the Heating of the Rangoon Electric Cable.

I have been informed that a knot of this cable weighs $2\frac{1}{4}$ or about 2 tons per mile. Experiments upon the heat given out during the oxydation of iron, show that for every pound of iron oxydized, it would raise two tons of the metal 15° Fahrenheit.

Each mile of wire during the oxydation of 1 lb. of the wire covering its surface would therefore be raised about 16°.

In order to form an approximate estimate of the quantity of iron that had undergone oxydation during the heating observed in the course of its manufacture, while on the premises of Messrs. Glass and Elliot, I detached as much as posssible of the oxide of iron from the surface of a piece of the cable. I found that a sample of this cable, cut at my request at the beginning of October 1860, from the centre of the heated coil, and representing a fair average sample of its condition, furnished about 66 grains of oxide of iron, the length of this portion being two feet.

This oxide would amount to 24·9 lbs. per mile, which would be equivalent to nearly $17\frac{1}{2}$ lbs. per mile of metallic iron which had undergone oxydation, a quantity amply sufficient to account for the heating of the cable observed.

The rusting of the iron, it may be stated, was entirely confined to the external surface of the iron wire, the parts of the wire in contact with the tarred hemp having perfectly preserved their brilliant metallic surface and aspect. (Signed) Wm. Allen Miller.

TELEGRAPHIC DELAYS.

Electric telegraphy has hitherto kept pretty well out of the law courts; but as that wonderful system of communication becomes developed, we have no doubt that the facilities it may present in a litigious point of view will become more and more apparent, and will be taken advantage of with great alacrity and gusto. We foresee a fine young crop of lawsuits springing out of the systematic delay, inattention, and slovenliness, which are at present the chief characteristics of the transmission of messages by electric telegraph. There has just been heard in the Sheriff's Court a very curious case, which, although the telegraph company did not appear in it as actual plaintiff or defendant, may be considered as bearing directly upon the subject-matter of our remarks. The stake at issue was not a large one—only a few pounds; but the principle involved seems to us of the very highest consequence to the comfort and convenience of the public. The plaintiff in this suit was a livery-stable keeper, the defendant a stock-broker. On the 12th of last June the plaintiff received a telegram ordering a carriage and pair to be at the Richmond Railway Station at eleven o'clock on the following morning, in order to convey the defendant to Ascot Races. The message was received at one p.m., and at two the plaintiff took an answer stating that the carriage, as ordered, would be in readiness at the time appointed at the Richmond Station. It was duly there at eleven on the 13th, but the defendant never made his appearance. The livery-stable keeper, consequently sued him in the Sheriff's Court, when the stockbroker pleaded that he waited in his office in the city, for an answer to his message until half-past four on the afternoon of the 12th, this being half an hour beyond his usual time; and that, receiving no reply, he concluded the plaintiff could not accommodate him; and so procured a carrriage elsewhere. It was admitted that the message placed in the hands of the telegraph clerk at Richmond at two p.m., was not delivered in London until a quarter to five. The commissioner ruled that, if this unconscionably late delivery arose from negligence, the defendant was not liable, and that the plaintiff's remedy lay against the Electric Telegraph Company; but that, if the message was, as pleaded, only delayed through stress of business at Richmond, and the necessity of each telegram having to wait its turn for transmission, the defendant was liable. The jury concurred in the last named view of the question, and the unlucky stockbroker will consequently have to pay seven pounds five shillings, and goodness knows how much costs, because the the telegraph clerks at Richmond could not manage to forward a message placed in their hands at two o'clock, until nearly five in the afternoon.

It is not at all unlikely that we are speaking in a needlessly grandiloquent manner in employing the term "Telegraph clerks." If the business at some of the principal London stations—notably the one at the Regent circus, Piccadilly—can be left in the hands of an impudent and inattentive boy, we can easily imagine that the country stations are abandoned to still more inefficient supervision. We only wonder that the management of a most delicate and beautiful instrument is not confided to the lame, the halt, and the blind. To the employment of females in the telegraph offices we have not the slightest objection. These young ladies, for their majority fully deserve the complimentary appellation, are generally as quick-witted as they are quick-fingered. They are intelligent, dexterous, and polite; and the avocation is one we think eminently suited to the feminine intellect. Nor do we object to the services of educated and civil young men; but it is positively disgraceful to see how, in too numerous instances, the "Telegraph clerk." both in London and country stations, is some lubberly boy who ought to be at school; and who, through the meanness and shabbiness of emyloyers who wish to save the wages of a full grown man, is promoted to a station far beyond his acquirements, and who his wholly incompetent to satisfy the public demands. It is ten to one when you enter one of the telegraph offices to find the hobbledehoy clerk either asleep with his shock head resting on his arms, or "skylarking" behind the counter with some comrade as loutish as himself. It is ten to one that he makes some gross blunder, either in charging for the message or in sending it, but these nuisances, grave as they are, do not produce so much inconvience as the systematic delay in transmission. We have heard, on very good authority, of cases at district offices where the operators have not even condescended to work off the message by means of the wire, but have coolly copied it out, and sent a messenger with it to its destination. It takes two, it has taken three, it has taken four hours to send a message of fifteen words from Fleet street to a village twenty-one miles from the metropolis. The sender of the message has been able to hail a Hansom, drive to Paddington, catch a train, and reach his destination long before the arrival of his own telegram. Is this abolishing time and space? Is this putting a girdle round the earth in forty minutes, with other fine things which we were promised when District and United Kingdom Telegraphs were established! On the Continent we grow accustomed to such delays. We know that the wires are, if not in the hands of the Government, so managed as to give the most trifling bureaucratic business priority over the most important private message. We can understand, although we are indignant at it, the snail-like course pursued by the Russian and Prussian telegraph officials, and which was recently exemplified in so remarkable a manner at St. Petersburg, when the telegram announcing that Prince Alfred was on his way to the Russian capital arrived exactly eight hours after his advent, the consequence being that the young Prince landed in a strange city without a soul to receive him, and was compelled to hire a public droschky to convey him to the British embassy. But these things are not to be tolerated in England. When to the scandalous delays we speak of are added the extortionate charges for porterage and the defective service on Sunday, as though telegraphy were not of all things a work of necessity, as though people did not fall down in fits or die on the Sabbath, it ceases to become a matter of surprise that the dividends hitherto derived from electric telegraph undertakings have been of infinitesimal amount, and that the operators at some of the London district stations have found it save them trouble to send a boy with the message ready written from one end of town to the other instead of working it through the wires. Electric telegraphy, properly organized and developed, would be not only a social benefit, but a social blessing. As at present conducted, it is nothing better than a delusion and a snare.—*Daily Telegraph.*

PRICES CURRENT OF INSULATING MATERIALS.

Gutta Percha

Has latterly attracted more attention, and buyers have evinced some inclination to purchase. Privately some sales have been effected at extreme rates for really fine genuine.

India Rubber.

Market quiet, with more disposition to sell.

Fine Para	1s. 11d. to 2s. per lb.
Negro Head	1s. 1d. to 1s. 3d. „
Java	1s. 4d. to 1s. 5d. „

August 27, 1862. Wm. Kirkmann,
4, Howford Buildings, Fenchurch Street, E.C

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THE EARNINGS OF TELEGRAPH COMPANIES.

The following table shows the average dividends paid each year for the last five years, by the three principal telegraph companies in this country.

	Electric Co.	Magnetic Co.	Submarine Co.
Year ending June 30, 1858 -	7½ per cent.	5 per cent.	8 per cent.
" " 1859 -	6¼ " "	5 " "	6 " "
" " 1860 -	7 " "	4½ " "	4 " "
" " 1861 -	7 " "	4½ " "	2½ " "
" " 1862 -	7 " "	4 " "	1½ " "

These figures show that the oldest company, the Electric and International, has not only held its own against its great competitor, the British and Irish Magnetic Company, but that the dividend of the latter has fallen since 1859. This has no doubt been caused in great measure by the change from an underground to an overground system, which materially interfered with the efficient working of the Magnetic Company while the change was in progress, and added greatly to the expense of maintenance for the time.

The important districts occupied by the company, and the absence of any great fluctuation of expenses arising from nearly the whole of their lines being by land, together with the steady development of receipts, render the prospects of the Magnetic Company as a steady dividend-paying and improving concern, better than many others, which seem, at first sight, to promise more brilliant results.

The Submarine Telegraph Company does not come out very well in regard to the dividend paid for the last few years, which have in fact been upon a gradually descending scale. If the company's earnings proceed much longer in the same ratio, the shareholders will be very awkwardly situated.

The expenditure of the Submarine Company for the same period was as under, including directors' salaries, and repairs to cables.

Year ending June 30, 1858 - - -	£13,330	0	10
" " 1859 - - -	12,617	0	10
" " 1860 - - -	23,048	8	1
" " 1861 - - -	24,111	11	9½
" " 1862 - - -	22,727	4	8½

Nor do the prospects of the future appear to be very encouraging unless some radical change can be effected. For the first few years of the company's existence, the cables required little or no repair, but the outlay for repair during the last five years has amounted to upwards of £26,000.

Looking forward to the further effects of time upon their cables, amounting in all to 870 miles in length, it is evident that in addition to the cost of yearly repairs on account of injury by accidents, a very large sum will be at some time requisite to replace the whole, or at all events a large part of the lines. For this we believe no proper provision has been made, although the earliest of the cables, that between Dover and Calais, was laid in 1851, and is said to be in a very bad state as regards its exterior coating, while the Dover and Ostend line was laid as long ago as 1853.

It is true that a "Reserve Fund," used to be spoken of in the directors' reports, indeed in their report of March, 1859, they said "the amount of reserve fund previous to these accidents will therefore remain intact." On this occasion 7 per cent. was paid in dividend, and the directors' allowance was increased, with the usual congratulations, from £500 a year to £1000. The committee of shareholders, however, which sat the next year, recommended that "the heading of 'reserve fund' should be abandoned until the time that such a fund shall be available, and actually in hand, which is not the case at present." Since that time no reserve fund has been formed, and the directors have made the unfortunate discovery that they have been paying many thousands of pounds, in past times, out of capital which ought to have been paid out of revenue, as stated in their recently issued report, without any further explanation or details.

The theory is now propounded by the directors that 10 per cent. on the gross *receipts* is the proper amount to be set aside for the reserve fund, and accordingly £2,820 4s. 9d. is appropriated in the revenue account for that purpose, while the capital account shows £293,190 3s. 7d. as the cost of the cable, so that the amount estimated to replace the lines (even in the face of the fact that the cost of the ordinary repairs has become so large, and will increase), is less than one per cent. upon the outlay.

Telegraphic News.

TELEGRAPH POLES.

In all the new lines of the Electric and International Company, in the south of England, Mr. Preece, resident engineer to the company, is putting up but ten posts per mile. their average distance apart being, therefore, 528 ft.

The following letter has appeared in the *Times*:—"Sir,—It has been for several years past the ambition of many scientific adventurers to extend our telegraphic intercourse with distant countries; and although they have as yet failed to complete the line to America, it is believed that we can communicate with India by means of the telegraph *viâ* Jubal in about 15 or 16 days.

"Now, having made use of the Telegraph to India on many occasions during the past few months. I have had ample opportunity of testing its efficiency. I find that the messages rarely miscarry, which proves that the condition of the line is satisfactory, looking at it from a scientific point ot view; but, connected as I am with the commerce of India, I looked forward to being able to make use of this telegraph commercially.

"In business accuracy is most important in every way, and certainly in this particular I cannot praise the company, who have established themselves for the purpose of increasing the commercial prosperity of this country.

"No telegram that I have seen, either from India to England or *vice versâ*, has reached its destination in an intelligible form, and lately, in many instances, the messages received have been so ridiculous as to preclude any one understanding their meaning.

"I certainly think that the heavy charge made for these messages warrants me in calling your attention to this, and I hope that the company may consider it expedient to employ more competent persons to read and telegraph the messages, as now they must be placed in the hands of officials entirely devoid of common sense.

"I enclose my card, and trust you will insert this on behalf of

"A Victim to Telegrams.

"*London, August*. 28."

On Tuesday, the 26th inst., a series of very interesting experimental tests were carried on at the extensive cable manufactory of Mr. William Thomas Henley, at North Woolwich. The core of the cable upon which the tests were made was manufactured by Messrs. Hall and Wells, of the Telegraph Works, Borough Road, Southwark, and sheathed with galvanized iron wire by Mr. Henley. The copper conducting strand is insulated with india rubber. There were present Sir William O. S. Brooke, Dr. Green, Walter Hall, Esq., — Hay, Esq., the patentee of the well-known marine glue, Mr. Owen Rowland, Electrician to the Telegraph Committee of the Board of Trade, &c. We hope that in our next number we shall be able to place before our readers a full account of the test to which this important cable has been subjected, and other particulars which will prove interesting to those engaged in the extension of submarine telegraphy.

The French telegraphists at Paris have lately exchanged messages direct with Krusk in Siberia, a distance of 3,600 miles, this is the greatest distance yet accomplished by the electric telegraph.

Mr. C. Laws, and the remainder of the staff of electricians and cable hands who were engaged with Mr. Latimer Clark in the examination of the Red Sea and India telegraph cable have just returned from Egypt, where they were engaged in the restoration of the Jubal line which had been temporarily interrupted.

Professor Hughes has lately sold his invention for type printing to the Italian Government, and the Paris makers have extensive orders for the manufacture of these instruments, which are also now largely used by the French Government on their most important circuits. The instrument has been greatly improved and simplified, and the type wheel now carries fifty different letters, figures, and other signs.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

ELECTRIC INDUCTION AND INDUCTIVE CAPACITY.

To the Editor of The Electrician.

Sir,—I should be glad to know what your correspondent "Amicus" really imagines "induction" and "inductive capacity" to be. An expla-

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nation on this point might be beneficial to some of your younger readers, whose ideas on the subject have not yet assumed a definite form. It is amusing to observe the mistakes "Amicus" is led into through not having apparently the slightest acquaintance with the subject he has taken up in his last communication; a fact the more to be wondered at as the meaning of the terms in question has been clearly explained in the columns of The Electrician *apropos*, I think, of one of his former lucubrations. If any objection is to be made to the text taken from the Government Report it is exactly the contrary to that which has been taken by "Amicus." The passage, it should be understood, refers only to a few materials used for the insulation of telegraph wires, and so far it may apply correctly. But, generally speaking, the more perfect the insulating property of a non-conductor, the higher is its inductive capacity. This is the law, to which, as in other cases, there may be exceptions. Spermaceti is a better insulator than atmospheric air; it is also a better dielectric. Glass is a better insulator than spermaceti; its inductive capacity again is higher. Shellac is a better insulator than glass, and follows the same law. So with sulphur *versus* shellac, bees-wax *versus* rosin, &c., &c., &c. With the sole exception of caoutchouc, it would be difficult to find a substance of higher insulating capacity than gutta percha, which should not be also a better dielectric. The assertion which concludes your correspondent's letter is not only, therefore, completely without foundation, but expresses the converse of the actual fact. It is probable that if pure gutta percha could be obtained by a process which would leave its original structure intact—which does not appear to be the case in Dr. Cattell's process—its insulating property, like its inductive capacity, would be found superior to that of caoutchouc. In this case, almost the only exception to the general rule would be removed; and the law that the inductive capacity of different materials varies according to their intrinsic insulating capacity, would not be liable to be misunderstood in telegraphy.

Should "Amicus" require a substance of which the inductive capacity is *nil*, I shall be happy to present him with a plate of copper. But he may, perhaps, perceive that this will be a very bad dielectric, and it is to be hoped he will not argue that it is on this account a good insulator. Should he in return favour me with a specimen of any insulating material, I may be able to form of it a Leyden jar, and practically to demonstrate in a conclusive and—may your readers pardon me—a shocking manner, that it is possessed of a high inductive capacity.

A Practical Electrician.

To the Editor of The Electrician.

Sir,—In No. 41, you mention your having produced a "cut" for your pages by electro deposition.

Numerous efforts have been made to render the electrotype process useful for the production of original blocks for surface printing. Can you inform me whether anything likely to supersede wood-engraving has yet been discovered, or if such an achievement would now be appreciated.

The interesting subject of electro motive power has not yet received any notice from you. There is a great want of practical information which tends to retard the progress of experimenters in this department of applied electricity.—I am, sir, your obedient servant, D. H. S.

Aberdeen, Aug. 25, 1862.

To the Editor of The Electrician.

Sir,—I have been in the habit of using a series of Smee's batteries for galvanic experiments, and have suffered considerable annoyance by a whitish substance that is deposited on the silver plates, and which stops the proper action of the battery.

If you, or any of your correspondents, can tell me how to remove that substance, and prevent its formation, I will be very much obliged.

Pray can you tell me, also, how to make varnished paper for insulating purposes.—Yours, &c., John King.

King Street, Whitehaven, August 25, 1862.

To the Editor of The Electrician.

Dear Sir,—The "Annales Telegraphiques" for May—June state that the noise made by suspended wires may be prevented by screwing short pieces of wood on each side of them. Two pieces, say two feet long by one inch square each, would perhaps be sufficient for each stretch of wire. The experiment is well worth trying.

A B C D is perhaps not aware that the present Morse alphabet is constructed on the plan of using the fewest signs for the letters which most frequently occur.

As it is used throughout Europe it would be impossible, or nearly so, to obtain the adoption of a new system.

The double needle alphabet is arranged so as to be easily learned. This being of more consequence than that its speed should be increased.—Yours obediently, R. S. Culley.

Bristol Station, August 25, 1862.

[This plan was adopted by Mr. Owen Rowland in 1858, in deadening the sounds of aërial wires between the Houses of Parliament and Lambeth, across the Thames.—Ed. E.]

To the Editor of The Electrician.

Sir,—Your Correspondent, A B C D, of the 22nd instant, asks for information as to the relative frequency of recurrence of the letters of the alphabet. This he will find sufficiently near for his purpose, in a type-founder's bill of type (pica Roman, small letters), which I transcribe below in the order of their frequency, merely omitting two cyphers from the right hand of each of the numbers given, which however does not alter the relative proportions required.—I am, sir, yours, &c., &c.,

August 26, 1862. Q. E. D.

e 120, t 90, a 85, i n o s 80 each, h 44, r 62, d, 44, l 40, u 34, c m 30 each, f 25, w y 20 each, g p 17 each, b 16, v 12, k 8, q 5, j x, 4 each, z 2.

OHM'S LAW.

To the Editor of The Electrician.

Sir,—It seems to me that the difficulty stated at p. 182 of your last number arises from leaving out of consideration that E, the electromotive force, has a certain numerical value dependent on the nature of the couple under examination, and if any given couple be assumed as a standard, the value of E in all other couples may be determined and stated as bearing a certain proportion to that standard.

"The electrical force being one way in which the chemical affinities of the several parts of the couple manifest themselves."—"Gavarret," Vol. i. p. 415.

In your first case,—zinc iron and zinc copper in acidulated salt water—let us assume the value of E in the latter couple to be 400, and the resistance of the battery (R), and galvanometer (*r*), to be 10.

$$\frac{E}{R+r}=\frac{400}{10}=40.$$

The energy of the electricity producing force (E), of the former couple is greater than that of the latter, and its numerical value as compared with it will be greater also. Let us take it at 700, or assume that the electric forces of the two couples are as 400 to 700.

The resistance of the battery couple being unaltered, then—

$$\frac{E'}{R+r}=\frac{700}{10}=70.$$

I take these values for E and E′ in order to bring out your figures in the result. It of course does not matter for the present purpose, whether they are exactly correct or not.

In your second case, removing the copper element from the water to the acid increased the chemical action, and exalted the value of E *without in any way altering the resistances*, hence the increased value of I.

The writer of the article states the interior resistance of the battery *was* affected. It is hard to see how this could occur, at all events in a sufficient degree to alter the deflection, nor does he venture a hint in explanation.—Yours, R. S. Culley.

Bristol, August 26, 1862.

[The value of E, or the difference of the polar tension in the zinc iron couple is considerably *less* than that of E′ in the zinc copper couple. This should have been pointed out in the article in question. In regard to the concluding remark of our correspondent, it will be seen that R, *according to Ohm's formula*, must be affected in the instance given—since *r* is not altered. The difficulty of explaining this, if R is held to be generally (and not in each particular case only), equal to $\frac{D}{S}$, is precisely what we had to show.—Ed. E.]

Miscellanea.

We are informed that during the recent submersion of the second portion of cable between Lowestoft and Zandvoort in Holland, a number of fishing boats were stationed every five miles to prevent the waste of cable by the "slack" usually attendant on the ordinary process of submersion. It is understood that as much as five miles of cable were considered to have been thus saved. We have as yet no detailed account of the mode in which the smaller vessels were utilized for the purpose in view; but, in several points of view, the system appears at first sight to be of questionable value.

In a paper "On the Mechanical Theory of Electrolysis" published in the *Philosophical Magazine* for December, 1851. Professor W. Thomson has shown that the mechanical value of the heat generated per unit of time in any fixed conductor of uniform metallic substance, is equal to the square of the electromotive force between its extremities, divided by its resistance.

To Correspondents.

⁂ Numerous highly interesting and practical questions have been from time to time addressed to the Electrician. Shall we appeal in vain to our numerous readers for their assistance—especially those who are blessed with the opportunity to enable us to conform with the wishes of our correspondents.

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The Electrician.

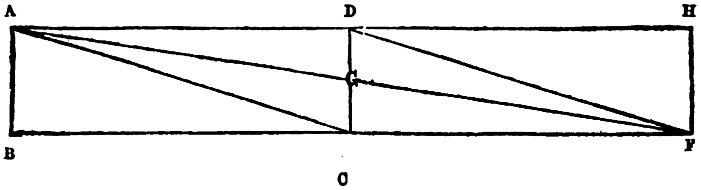
VOL. II. No. 44.—SEPTEMBER 5, 1862.

CONTENTS:

	PAGE		PAGE
Discursive	205	Moral Causes	211
On the Nature of the Forces that Actuate Matter	206	Prices Current of Insulating Materials	213
Some Considerations on the Principles of Electrical Conduction and Accumulation	207	The Progress of Telegraphy	213
On Railway Telegraphs	209	Telegraphic News	213
Mr. Shepherd's Electro-Magnetic Clocks	211	Telegraph Shares	215
		Correspondence	215
		Miscellanea	216
		To Correspondents	216

DISCURSIVE.

WE cannot profess ourselves altogether satisfied with the manner in which our valued contributor, Mr. R. LAMING, has disposed of the geometrical illustration given (page 182) in support of the view we have taken in regard to the main question affecting the retardation of signals in telegraph wires. In the first place, we have, from the commencement of a discussion which the vast interests at stake upon a single scientific question renders of some importance, registered our objections to the view now adopted by Mr. LAMING, *viz.*: that "in double and triple lengths the resistance to charge, as well as the quantity of electricity accumulated, is doubled or tripled." This view, we contend, applies to wires which are insulated from earth at the extremity furthest from the battery, and, *therefore*, cannot apply to wires which are connected to earth, as in the case of telegraphic lines. We believe, that this can be rendered evident by a very simple process of inductive reasoning, which is now objected to on the grounds that the conditions assumed cannot be experimentally obtained, and have no counterpart in practice. That this is the case is sufficiently obvious, but we cannot perceive that it in the least invalidates our conclusion. There is, in fact, no need to assume impossible conditions. Taking the rectangle, B A H F, to represent, with mathematical accuracy, the distribution of the charge upon an *insulated* wire, B F, and the triangles, A B C and D C F, to represent with equal accuracy certain portions of this charge, we find that, if the portion, A B C, equal to half the charge upon the



length, B C, becomes accumulated in one unit of time, half the charge of the section C F, distributed, as shewn by the diagonal, D F, will occupy three units of time in its accumulation. This deduction, which follows from the geometrical representation of the physical conditions, is also true in a physical point of view, notwithstanding that it cannot readily receive an experimental demonstration. If it be now admitted that half the charge of the double length B F, distributed, as shewn by the diagonal A F, becomes accumulated in a less period of time than does an equal quantity according to the above distribution, it follows that the ratio for the periods of charge of single and double lengths is not as the squares of these lengths; and the same must be true also for other lengths of wire. The conclusion is logically inevitable, and we do not perceive in what point the premises are open to question.

Turning from a question of theory to one of practice, we are glad to observe that the difficult problem connected with the production of the electric light, *viz.*, the regulation of the charcoal points to a constant determinate distance, appears to have been most perfectly solved by M. VICTOR SERRIN, who has latterly, at the Polytechnic Institution, afforded to an English audience the opportunity of judging of the value of his invention. Of the many different contrivances which have been proposed for the purpose in view, that of M. SERRIN is, perhaps, the only one which satisfactorily fulfils all the conditions required in practice. We hope shortly to give a detailed description of the apparatus; but we may now briefly refer to the principle of its action. The *regulateur* of M. SERRIN works automatically, through the agency of the voltaic current producing the light; and it, therefore, requires attention only at considerable intervals of time, when a fresh supply of carbon becomes necessary. By an ingenious reciprocal arrangement, or what the inventor terms a *système-oscillant*, two different mechanisms are alternately brought into action, the one operating when the current ceases, or when its force is diminished, and tending to bring the carbon points into contact; the other tending to separate these points and becoming active when the current obtains its *maximum* effect. Thus the rods of carbon, which are in contact when the battery circuit is incomplete—a necessary condition for the production of the voltaic arc, become separated by a certain interval when the circuit is completed through the instrument, this interval, and the length of the arc of light, being dependent upon the intensity of the current. For, the resistance of the circuit being necessarily increased by the separation of the carbon electrodes, a point is soon reached when the force of the current becomes insufficient to maintain the action of the mechanism performing this function. When, by disintegration and combustion, the distance between the points becomes further increased, the first-mentioned mechanism becomes again active, bringing these points into closer proximity. The following are among the applications of the electric light to which the inventor has directed his attention, *viz.*: for lighthouses, navigation, mines, night signals for military and naval purposes, subaqueous work in recovering freight from sunken vessels, in the construction of bridges, and in the coral fisheries, scenic effects for theatres, the public *fêtes* so common in Paris, works of construction carried on during the night, and photography. At the present moment, the latter application especially claims our attention, a cheap, efficient, and easily-manageable source of artificial sunlight being a recognized desideratum for photography, which we believe now to be attainable.

Some attention has been given to a system of telegraphic transmission for submarine lines, suggested in a former number, and which bids fair to remove the principal objection, both in a scientific and a commercial point of view, to circuits of great length. We will, for the present, forbear from entering into any disquisition upon the scientific questions involved. and confine ourselves merely to the indication of the means to be employed, and the results which are anticipated. Our readers may thus study the problem for themselves; and, for the benefit of others, some may, perhaps, be inclined to favour us with the conclusions they arrive at from the data given. The cable would be thus constructed:—A wire, or strand of copper, is covered with a thin coating of gutta percha, sufficient for the purpose of insulation, but necessarily possessed of considerable inductive capacity. The insulated wire is then encased, spirally or otherwise, with iron or steel, or a combination of metals possessing considerable tensile strength and a sufficient conductive capacity for the purpose in view. The primary and secondary conductors are now insulated with gutta percha or caoutchouc; a considerable thickness of insulating material being in this case employed. The cable may be externally protected when necessary by any of the known methods. When submerged, the receiving instruments at each station are connected with the secondary conductor; battery contact being made with the primary wire only. Thus, in this system, there is no voltaic circuit, the signals being obtained by electric induction. When necessary, however, the primary wire may be used for the call signal or other purpose, though, in the

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course of transmission, it would be insulated at the receiving station. Let us suppose the call signal to have been given; the instrument at the receiving station, adapted for reverse currents, and already attached to the secondary wire, is connected to earth. At the transmitting station battery contact with the insulated primary wire is now rapidly made and broken; the secondary conductor being insulated at this station. What is anticipated is a corresponding series of reversed currents traversing the secondary wire, a reversal for every make and break. Can we yet cry, *Eureka?* The system, of which the resources have been but imperfectly glanced at, is worthy of the careful investigation which it has already received, with satisfactory results, from very able hands. We hope shortly to give some details of a practical nature of the experimental results with short lengths of cable constructed upon the plan we have described. It is evident, however, that the system is peculiarly adapted for long lengths of submarine wire, and would be tested under great disadvantage by means of a portion of cable possessing but a small inductive surface.

ON THE NATURE OF THE FORCES THAT ACTUATE MATTER.

BY RICHARD LAMING, M.R.C.S.

AUTHOR OF "STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY."

A MODERN philosopher, not unknown to telegraphists, has suggested, apologetically, for having imputed to the forces in matter a chamelion-like nature, that a dwarf upon the shoulders of a giant may see farther than the giant himself; to complete the allegory may we not suppose the giant so great as to have raised the head of his little friend into the clouds, in which case it would have been better for him to have staid below and seen only half as far through a clearer medium. Some of the giants in physical science, in this country, are waiving the consideration of matter altogether for the more tangible entity of force, and the notion has at length been put into a dress that is highly poetical. But without discussing with Faraday and Harris whether matter consists only of its forces, or with Grove whether the forces, known as physical, be convertible into one another, I will pass on to notice a dilemma, which, if properly considered, seems calculated to lead to an important conclusion. The existence of force pervading the universe is not to be denied, and, consequently, we must think of it either as a created or an uncreated thing. If it be, like the matter it actuates, a thing created at the beginning, once and for all time, we cannot suppose it susceptible of destruction, its quantity must remain unchangeably the same. But we know that the force of gravitation, emanating from a given point, increases two-fold whenever it is directed upon a double quantity of matter, and four-fold when the portion of matter it is acting upon is brought within a half distance. What we call electrical force varies, too, in quantity with the matter it is acting upon, in a very remarkable manner peculiar to itself. We enquire of Faraday—are gravitation and the electrical forces created things? he replies in the affirmative; but cannot reconcile to his conclusion the observed fact of their variable quantities. Grove avoids Faraday's perplexity by suspecting that gravity and electrical attraction, in common with the other forces in matter, have an innate power to change, under particular, but unknown circumstances, one into another; so that gravity may become electricity, electricity heat, heat gravity, and so forth, in an endless and entangled chain, and thus he would introduce Alchemy the second, the transmutation of forces instead of the defunct correllation of metals,—for such a transposition of the words is quite permissible, and somewhat suggestive. To the writer not professing to be giant and hoping not to be pigmy, but an ordinary enquirer, content to see things at their usual level, all this seems a cloudy flight into the realms of fancy; at all events it is an assumption that is unnecessary. There is no need either to shut our eyes to the variableness in the quantity of any force, or to account for it by transmutation. We can take a more simple, and, as it appears to me, a more justifiable view of the nature of force. How do we know that force has ever been created? Certainly not simply by the facts of its existence and operation. If we go so far as to assume the creation of force, then we must acknowledge the existence of a moral power capable of creating it; and that power itself, acting by its mere will from points in space, according to any preconceived and faultless plan, would render the creation of force unnecessary. A moral power that we can imagine capable of creating forces to actuate matter, cannot be supposed incapable of doing its own creatures' work, nor can untiring energy feel it needful to take shelter in an agency from a fatigue of incessant government. We call the Creator of the Universe its Preserver; are we consistent in denying the necessity for preservation by making the universe automatic, by virtue of inherent force, even supposing it to have been created?

We really might accustom ourselves to contemplate a moral commencement of physical force without any very great stretch of imagination, or doing the least violence to our reason; for in our own personal experience we have already learned something about the physical effects of moral volition. It will be no unwarrantable use of analogy if we extend the lesson beyond the boundary of observation; and if we do this, carrying it to its utmost conceivable limit, the necessity for created force will immediately vanish. The moral power that delegates our own must have a will in constant exercise.

The only sense in which we can with reason call any *originating* force physical is with reference to its effects, not its nature; and in that sense moral force is physical, whether exerted by the mind of the Creator, or his creature. Faraday, than whom there are, perhaps, none more accustomed to appreciate such considerations, is of opinion, that in science generally we should have as few assumptions as possible; we are certainly entertaining one unnecessarily, so long as we interpose anything between creative volition and its creation, while it is possible, reasonable, and sufficient to regard physical force as an incessant exercise of moral power for the production of physical effects, according to a predetermined and uniform order.

To electricians, who study more for the improvement of their art than their science, this subject may appear abstruse; to others it will be useful when contemplated side by side with the other horn of the dilemma upon which electrical physicists are tormented, who cannot bring themselves to discuss the question. He who refuses to believe in the moral nature of electrical force continues to be involved in a difficulty from which there is not a single doctrine consistent with the acknowledged principles of natural philosophy that can help to extricate him. That electricity acts with a force which varies as the squares of its quantities is as firmly established by observation as the laws of gravity themselves; and how shall we explain a variable amount of force while we make the force as an inherent created thing unalterable? Harris, to use a vulgar expression, staggered at the ratio, though he himself has abundantly proved it as a fact, exclaims—"To suppose an effect to be as the square of its cause, is to suppose the effect to depend partly on the cause and partly on nothing." Not so, I firmly assert, if so be that the cause is a volition not measured by its effects; but so plain a way out of the difficulty has been contemned as unworthy of correctly thinking men, or at least ignored as a step beyond the confines of physical philosophy, though at the inevitable alternative of doing violence to acknowledge physical principles. Nothing is better known in physical philosophy than the equality of action and reaction, and in conformity to that axiom the force with which electricity acts upon anything must be precisely equal to the force with which that thing acts upon the electricity; but as equality does not suffice for the urgencies of electrical attraction, we are required to tolerate an inequality, and just such an amount of

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inequality too as may happen in each particular case to be wanted. Inconsistent as the alternative is, impossible as would be its justification, it has not wanted mathematical supporters, their calculations being based upon the fiction that force between opposite things, like a face in opposite mirrors, may be multiplied by *reflections*.

On the other hand, if we adopt the moral nature of electrical force, we are free from all difficulty; few now deny the existence of a will competent to act universally upon matter, and it is quite easy to perceive that when once volition has initiated physical events, physical causes and effects would follow in succession, and each be measureable by every other in the same series; and if we want an analogy for this we have it: using the word in a subordinate sense we are justified in saying, our will creates its first physical effect within our frame, whatever that effect may be; thenceforward the effect is rigidly amenable in all its consequences to the axioms and principles of mehanical philosophy, the whole sequence of secondary causes, from first to last, being greater or less as the originating volition within the compass of its delegated power may have first determined.

What I, therefore, think ought to be assented to with respect to the electrical attraction with which the readers of this journal have more particularly to do, is this—the force with which electricity attracts common matter varies as the squares of the quantities of electricity, because such *was* and *continues to be* purely and simply the will of the Creator and Preserver of the Universe actuating matter in a direct manner without any intervening agency. If electricians adopt that simple view, they will leave in full authority all the mechanical axioms without being driven to the reflections of physical force invented for the undue extension of one of the mechanical axioms only by a gross violation of another. The time has passed away when even philosophers need hesitate to acknowledge belief in an universal moral origin; and if it be a truth, it is one we must sooner or later place at the beginning of our physical systems.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 199.]

WITH regard to the sense in which English electricians employ the word "tension" in the present day, it will be found, as far as publications allow us to judge, that the word is generally employed in a sense similar to that in which the French employ it; but still there is sufficient to show that the term is used occasionally with considerable latitude, and sometimes to convey by itself impressions of a state of things which cannot be thus expressed, or rendered comprehensible, by a single word.

Unfortunately, we have no standard English work on electricity which treats of the phenomena of the electroscopic force that different parts of a circuit, as enunciated by Ohm;* the only allusion to that law, in English works on electricity, consisting of a brief description of the formulæ for the magnitude (or intensity) of the current. The evidence given before "The Board of Trade and Atlantic Telegraph Committee," and the several reports and papers in the appendix, form perhaps the most modern publication in English on electricity; and by a review of the sense in which the term is there employed, we may obtain samples of its application in the present day, or at least for the time at which the report was published.

Professor Wheatstone, in describing experiments to ascertain the "Influence of the electromotive force of the battery on the amount of discharge," says:—

"The fifth column gives the *tensions of the battery* ascertained by Peltier's electrometer; the high tensions are not given because beyond 30° the forces are no longer in proportion to the angles."

Here the electrometer gave the measure of the *tension existing between the two poles of the battery* when one or both are insulated from the earth; for with a proper electrometer the outer armature being connected to one pole, and the arms to the other pole, no difference would be obtained in the effect on the instrument by connecting either pole by itself to earth. This test, therefore in fact measured the electromotive force; or what Ohm would term "the sum of the tensions;" or, supposing one pole to earth, what some electricians would term the difference of tension between the insulated pole and earth, and the tension of the other pole being *nil*, consequently the difference of tension between the two poles; or what others would no doubt term the difference of potential between the insulated pole and earth, and consequently the difference of potential between the two poles.

The term is here it appears used in a legitimate sense, because the electromotive force is always proportional to the tension existing between the two poles when insulated entirely from one another. or the difference of the tension existing between each pole and some common conductor, and consequently the term tension in this sense can be employed in all cases instead of electromotive force; but as electromotive force can certainly not be employed in all cases instead of tension, it would perhaps tend to avoid confusion if the term "tension" were never used in those cases where "electromotive force" can be substituted.

In another part, Professor Wheatstone appears to employ the term in a very indefinite sense; thus he says:—

"When a telegraph is in operation, the wire is always connected with the earth at its opposite extremity. *The state of tension is in this case never arrived at*, because the current continues to flow, and at the moment of discharging the wire, only one portion of the electricity at that moment existing in it is discharged through the new path, the other portion passing from the opposite end of the wire to the earth, with which it is permanently connected."

Now according to most electricians, when a current is flowing through a wire, there exists between every point of the wire and earth a certain tension, although at each successive point of the wire this tension varies. The difference between the electric state of a wire insulated at its distant end attached to a battery, having its other pole to earth, and that of a wire so attached but having its distant end insulated, being simply that in the latter case the tension between the wire and the earth is uniform throughout the wire, being in all cases equal to the electromotive force, and in the former it is less at all parts than in the latter, and constantly decreases along the wire from the battery pole to the end which is connected to earth. By "*the* state of tension," Professor Wheatstone consequently implies this state of uniform and maximum tension throughout the wire, which is arrived at only when the conductive resistance is infinite, or, in fact, when the distant end is insulated. This appears therefore rather a special application of the term.

Mr. Varley, in describing experiments on the laws of accumulation, says:—

"Having first by experiment confirmed the statement that between equal surfaces inductive absorption was inversely as the distance between the inductive surfaces; *i. e.* if with *like tension of electric force*, and like surfaces placed at a distance *a*, from each other, the amount of electricity absorbed by the one plate (and driven out of the other to an equal amount) by induction, by *e*, &c." Here evidently, "if with like tension of electric force," stands for, *if with a given electromotive force.*

Mr. Varley, in speaking of magnetic storms, appears to use the term in two separate ways, one of which is rather peculiar.

"During the last autumn I succeeded in measuring some of the currents between London and Ipswich, and had to introduce an opposing battery of 140 cells of Daniell's battery to balance the current, showing therefore in the earth at Ipswich, compared

* I hope further on to supply this deficiency to some extent.

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with the earth in London, a *difference* of *electric tension* amounting to 140 cells of Daniell's battery. Taking this line, roughly speaking, at 60 miles, and assuming that the *same state of tension existed all the way across the Atlantic*, for a cable of 2,000 miles you would have a current of very great power flowing through that line, equal to from 4,000 to 5,000 cells of Daniell's battery, &c."

Now here it will be observed that the *difference* of tension between London and Ipswich is taken as the electromotive force producing the current observed, and which was found by Mr. Varley equal to that of 150 cells of Daniell's. Consequently, therefore, tension here implies the comparative electrical state at one place; or, supposing we for an instant illustrated the case by comparing electricity to a fluid such as water, tension would be represented by the level of the water, so that the difference of level between Ipswich and London would constitute the head of water, or electromotive force, producing the current.

Now, taking it in this sense, it seems, that if "*the same state of tension existed all the way across the Atlantic*," that the other side of the Atlantic would have the same electric state, tension, or potential as this side, and, consequently, that there could be no current. It is evident, therefore, that Mr. Varley employs the term this second time in a different sense, since he says, that in such case the current would be equal to that of 400 or 500 cells. The only conclusion that I can come to is, that Mr. Varley meant to imply, that if the electrical state of the earth constantly varied with distance in the same ratio between England and Newfoundland, as he found it did between London and Ipswich, then, by the proportion—as 60 miles is to 180 cells, so is 2,000 miles to 5,000 cells—the difference of tension between London and Newfoundland would be equal to 5,000 cells.

In this case, therefore, "state of tension" implies the difference or change in the electrical state *per unit of distance*; a sense in which it has never, to my knowledge, before been employed, and which is certainly confusing, considering the sense in which the term is before employed in the same paragraph.

Mr. Latimer Clark says "*Intensity* signifies difference or degree of *tension*, or that which is produced by increasing the number of cells in a battery; but, in its more popular acceptation, it has a very different value, and the effects of quantity are entirely confounded with those of intensity. For this reason I have, throughout the remainder of this report, discarded the word intensity, and used only the word *tension*, a term which will, I think, not be liable to any misinterpretation; it has the same signification as the word *potential*, as employed by Green and Professor W. Thomson, or as *electro-motive force*."

Now, it cannot be allowed that the word tension, as understood in our days, and if taken as synonymous with *potential*, is always the same thing as *electro-motive force;* because, as Mr. Clark himself states further on, electro-motive force consists, if we refer the tension of all points to the earth, of the *difference* of *tension* between two points. Thus he says:—"The amount of electricity which flows through a wire depends wholly on the relative tension of its two ends, and not on its absolute tension with respect to the earth." And again, in stating a formula:—"If T represents the electro-motive force, or the difference of tension at the two ends of the wire."

It is true, as I have before said, that the electro-motive force of a battery is proportional to the tension existing between the two poles, or the difference of the tension existing between each pole and some given conductor; but this does not render the two words synonymous.

Mr. Clark further remarks:—"With static electricity, the quantity of electricity on a given surface determines the amount of electroscopic attraction and repulsion, and it determines the degree of *tension*, while the *tension* reciprocally determines the amount of attraction and repulsion, and also the *quantity of electricity which shall be stored up inductively on a given surface*."

According to Mr. Clark, therefore, tension is simply proportional to the quantity on a given surface, or, in fact, to the density, the same as set forth by Sir W. S. Harris. This, as I have shown before, is not sufficient to define tension, because it is evident that we may have two insulated conductors of equal surface charged with equal quantities, and yet, if the surrounding objects connected to the earth be nearer to the one than the other, the tension between each and the earth will be different.

Although this definition cannot be accepted, there is no doubt from subsequent parts of Mr. Clark's report, that he employs the word generally in a similar sense to that in which it is employed by the French electricians.

Mr. Siemens also uses the word tension in a sense similar to that in which the French employ it, thus he says:—"In 1849, Mr. Werner Siemens proved that when a current is sent through a submerged cable a quantity of electricity is retained in charge along the whole surface, being distributed proportional to the *tension* of each point."*

A "submerged cable" may, perhaps, be taken as implying a wire of uniform section and conductivity, covered to an equal thickness throughout with a given dielectric, so that the inductive resistance separating the two conductors (*viz.*, the wire and the earth) to which the poles of the battery are connected, is equal over each portion of the wire, in which case the electricity would certainly be distributed proportionally to the *tension* at each point; but unless this condition be understood, or taken for granted, the mere enunciation that *the electricity will be distributed proportionally to the tension*, is, strictly speaking, incorrect; for if the wire were unequally coated, although the "tension" would vary directly as the resistance separating each point from the distant end to earth (and consequently, if the wire is of uniform section and conductivity, directly as the distance from the distant end), the *density* of the charge would *not* vary in the same uniform ratio.

Setting aside this omission, which, perhaps, it is scarcely fair to quibble at, Mr. Siemens may be said to employ the word tension in the same sense as the French, and some of the English electricians I have quoted.†

Professor W. Thomson does not, I believe, use the word "tension" in any sense connected with electricity; nor does he in his evidence before the committee on telegraphs, use any word in a similar meaning. The words "electrostatic potential" are employed by Professor Thomson in some of his writings in a sense apparently similar to tension, as used by other electricians, the word "potential" having, I believe, its origin in the theorems first propounded by Green. The specification of a patent taken out by Professor Thomson on the 20th February, 1858, supplies us with the following definition of "potential":—

"The 'electrostatic potential,' or, as the Professor says for shortness, simply the 'potential' for any point A in space, is a quantity depending on the position and electrical state of all bodies which act at the point A, for the present confined to all electrified bodies in its neighbourhood, and such that the difference between the values of the potential at the point A, and the potential at any other point, B, is a measure of the tendency of of electricity to flow from A to B, or, *vice versa*, supposing A and B connected by a small conducting wire. It follows from this, that, when there is equilibrium, the potential at every point of an electrified insulated conducting body, including every other insu-

* Mr. Werner Siemens may have been the first to observe the *effect* of the electricity distributed along a wire passing out at the near end, in the form of current, or, in modern language, "the return current," although, if I mistake not, according to a paragraph in the "Annales de Chemie," for 1850, the observations of M. Siemens on this subject were, at that early date, confined to the observation of the *charge* and *discharge when the distant end is insulated*. But be this as it may, Mr. Siemens cannot certainly claim being the first to "prove," that when a current is sent through a wire that electricity is retained on its surface and distributed in a certain way, according to certain laws, because Ohm's paper, published in 1827, gives us full information on this distribution. It is, at the most, the *effect* of the electricity, thus distributed, when passing out at one end of the wire, that Mr. Siemens can claim being the first even to observe.

† Of the terms generally used by the German electricians, I regret that my ignorance of the language prevents me from speaking. Considering the importance of Ohm's law, it would, no doubt, be exceedingly interesting to those English electricians who take an interest in electricity, to know, on the authority of a German electrician, the exact value and English interpretation of the original terms employed by Ohm, and whether they are still employed in the present day.

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lated conducting body connected with the first by wires, or other conductors, is the same, and may be measured, by connecting by a conducting wire, any part of the conducting body with any insulated electrometer of sufficient delicacy."

The specification, after describing the electromer, goes on to show that when a certain interior part* is connected to the earth and the "drum," or exterior armature, to the conductor which is to be tested, the effect on the instrument "measures the difference between the potential of the conductor tested and the earth." "In this way. too, the difference of potential of any two conductors may be measured." "If one of the two conductors so tested is the earth, then, as its potential is considered as zero, we get a measure simply of the potential of the other conductor."

I may briefly point out here that these tests for measuring the "difference of potential" between two points, would also measure the "tension" between those points, or the difference between the tension existing between each point and the earth. "Potential" and "tension," in fact, really imply the same thing viewed in two slightly different lights.†

Mr. Fleeming Jenkin, following Professor Thomson, also employs the term *potential;* and in the sense in which he employs it, the word tension, as used by the French electricians, or electroscopic force, as used by Ohm, might be substituted in certain parts, and the matter still stand in accordance with the laws of Ohm. Thus, in describing the electric state of a wire attached to a battery, the other pole of which is evidently assumed, though it is not so stated, as connected to earth, Mr. Jenkin says:—

"The *potential* of the internal wire of the cable, when perfectly insulated at all points, is equal to the *potential* of the pole of the battery with which it is in connection. In a well insulated cable this is sensibly the case, when one end of the wire is connected with the battery, and the other end insulated. When, however, the other end of the wire is connected with earth (as when signals are being sent), the *potential* of the internal wire varies at every point. Close to the battery the *potential* is still equal to that of the pole of the battery with which it is connected. Close to the end of the wire which is connected with earth, the *potential* at the wire is zero. At intermediate points the *potential* diminishes in direct proportion with the distance of each point measured by electrical resistance from the pole of the battery; thus, midway the *potential* is half that of the pole of the battery, and so on."

In the above "tension" might be substituted for "potential," and no one who holds to Ohm's law would disagree greatly with the substance of the quotation.

In another paragraph Mr. Jenkin uses a new term, viz.: "statical power," in a sense to which the term "tension" would equally apply. Thus he says, referring to the matter quoted above, "From what has just been said, it results that if 100 cells are used in signalling through a cable 500 knots long, a fault which exists midway will only be subjected to a *statical power* equal to that of 50 cells applied directly at the spot where the fault exists; and a fault 400 knots distant from the battery would only be subjected to a *statical power* equal to that of 20 cells."‡

It will be seen, from the quotations I have given, that although in the present day there is, perhaps, generally a tendency amongst electricians, both English and French, with the exception of those who employ the term "potential," towards a similarity of meaning when employing the term "tension," the latter word is still used with considerable latitude; and there is yet wanting a more general understanding as to the exact sense in which it is to be received, before we can hope to apply it without the danger of being altogether misunderstood unless we specially state the exact sense in which we employ it.

The alteration in the terms necessary to treat of Ohm's law from those which (according to Mr. Francis' translation), were employed by Ohm himself, is also embarrassing to those who attempt to read his original paper. Thus "a tension" of Ohm is what would be called now the electromotive force of a single element, or by some *the difference of tension* between each side of the surface of generation; and what Ohm termed "the sum of all the tensions" would now be termed the "electromotive force of the battery." "Electroscopic force" being, as I have shown, with the proviso I have already mentioned, now termed the "tension." So that there has been almost a crossing of terms.

Moreover, some employ the term "intensity" in a sense evidently the same as that in which others employ the word "tension." Now the word "intensity" as employed by the French and some English electricians, is applied more generally to electric currents, and in that sense has a perfectly definite and intelligible meaning, standing simply for the *proportionate quantity of electricity passing through a section of a conductor in a given time*, or what Ohm terms the "magnitude of the current."

It will be seen, therefore, that unless either some general understanding is arrived at, or electricians take more trouble, than they generally do, to specify the exact meaning of the terms they employ, the confusion of terms must become excessively embarrassing to those who study to unravel the purport of each particular author.

(To be continued.)

ON RAILWAY TELEGRAPHS.

BY W. H. PREECE, ASSOC. INST. C.E.

[Continued from page 197].

SIG. VINCENZI, an officer in the Italian army, has an ingenious contrivance exhibiting in the International Exhibition, whereby trains in motion receive and send signals of their approach to stations and trains on the same section of line. A projecting arm on the guards' van comes into contact with a horizontal longitudinal bar, situated at various distances on the line, and thus completes the circuit, which rings a bell.

Similar plans have frequently been suggested. This is by no means novel. Mr. Edwin Clark describes how an engine driver can learn the state of the signals some distance before he arrives at them, in the report previously alluded to, but as he very properly observes, "All the arrangements that have been thus proposed have emanated with a good motive from very ingenious individuals, but they have invariably been from persons who have had no practical experience in the difficulties and intricacies of an actual telegraph."

The most important application of the telegraph is unquestionably its introduction into the working of single lines. Where more than one engine is employed in the working of a single line, the use of the telegraph is rendered compulsory by the Board of Trade. It may be used in a primary manner to rule and regulate the signals of the various sections of the line as previously described, or it may employed in a secondary manner to give notice of the delay of trains, to hurry on one train, to delay another, to alter the authorized passing places, and to prevent the delay of one train producing impunctuality in all the rest. It is evident that in either case it becomes a most essential and important branch of the service, and one requiring the greatest care and attention. It is, however, the fact that on most railways the telegraph is held in the lowest estimation. The construction is the very last thought of—its convenience never considered. Government inspectors, if they see poles on the line, conceive that everything else must be complete. Railway

* So far as regards the meaning of "potential," this part may be taken as represented by the arms, *a*, of the electrometer, E (fig. 90).

† This point will be found discussed more fully further on, when illustrating and defining the exact sense in which I employ the word "tension." At present it will be seen that I am merely briefly reviewing the sense in which the term "tension," and its nearest substitutes in different theories, *viz.*, "electroscopic force" and "potential," have been employed by different electricians.

‡ It must be observed, that for this statement to be correct the resistance should be measured from the *pole of the battery which is connected to earth*, so as to include the resistance of the battery in the measurement. The figures given would only hold good, therefore, if we suppose the resistance of the battery infinitely small, compared to the line.

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managers order a telegraph and think no more about it. The signals, the switches, the porters' rooms, and the urinals, are all carefully considered, but the telegraph—the most important element of safety and despatch—is neglected to the last moment.

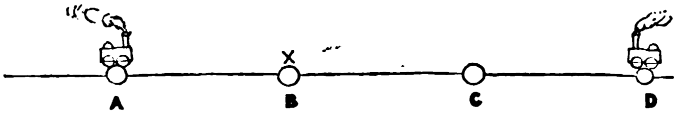
It is assumed that it can be fixed anywhere, and that any vacant spot in the parcel or booking office is sufficient for its purpose. Light is essential to ensure attention. Airiness is imperative to secure health, which is so easily impaired by such a confined occupation. Indeed, special offices should always be constructed at all stations. It is a mistake to combine telegraphy with other occupations. A booking clerk may be attending to passengers when he is urgently wanted at the instrument. A parcels' porter may be away when a danger telegram is being sent. Constant attention, which is imperative in a well regulated telegraph can only be obtained by having a special telegraph clerk situated in a convenient office, free from interruption, and undisturbed by the ordinary business.

Some single lines are worked on the block principle, others with Tyer's instrument. Many are worked on the "train staff," and ticket system, some by the time tables alone; the passing places of trains, in such cases, being altered by some authorized officer by telegraph. The "train staff" is a sort of truncheon, made of different sizes, forms, and colours; sometimes supplied to the guard, sometimes placed in a socket on the engine or tender. Each section of line has one apportioned to it, different and distinct from every other. No train is allowed to travel over that section without its staff. "During the operation of ballasting, or when an accident happens, the staff is supreme. It must be sent for an assisting engine, or must accompany the ballast engine; and no officer, or person in authority, can send forward an engine or train during its absence; but the most hurried director, or the most impatient manager must, as well as the third-class passenger, await its return."

With such systems in use collisions must become unknown. The time tables have only to be adhered to and accidents are impossible. If punctuality is obtained everything goes well. But delays must arise from a hundred different causes, and the delay of one train throws all the rest into irregularity. The telegraph now becomes available to restore order. Two trains are appointed to meet at B. That coming from A is punctual, that from C is late. It is found that the former can be sent on to C before the latter arrives there. C is therefore made the crossing point in place of B, but several precautions have to be adopted in carrying this out. There must be no mistake in the instructions given. The station masters, guards, and drivers, must all have explicit orders, and the superintendents must know that they have these instructions correctly.

On the Shrewsbury and Hereford Railway a collision with loss of life occurred in a case of this sort, from the insertion of the word "at" in the copy of a telegram, and from the general want of explicitness in the working of the message itself. On a railway in the north of Scotland the superintendent was himself killed in a collision caused by his own irregular orders. Everything depends upon the correctness of the message. On the London and South Western Railway a very complete and safe system is employed. Each single line is divided into districts of above 50 miles in length. Over each district there is a superintendent, who has the regulation of the traffic. Every train on its departure from certain fixed stations is telegraphed to the superintendent, who thus knows precisely how the trains are running. If a case occurs, as shown in fig. 8, he takes his measures accordingly.

Fig. 8.



1. A message is sent to C, ordering the stoppage of the down train.

2. This is repeated in slightly different language by the station-master at C.

3. A run up is sent to B, to send on the down train to C.

4. This is also repeated in a similar manner to the previous message.

5. The engine driver of the down train, if an express, is warned at his last stopping station that he will have to stop at C. No loophole is thus left for error or misunderstanding. Every man has his orders in black and white, and accidents can only arise from the wilful disregard of clear and explicit instructions. A regular form is adopted for wording these messages, and different coloured message papers are used for the different orders issued. Those respecting the stopping of trains are coloured *red*, those respecting the forwarding on of trains, *green*. Written orders are given to the driver, with a copy of the message itself. It will be seen that each alteration of a passing place involves four separate messages—in the case of an express train, five—each message being repeated to ensure correction. It is found, in practice, that all this is accomplished in a period averaging five minutes.

The greatest care is taken that everything shall be unmistakably written down. A message should never be sent by telegraph, unless it has been first written down on a proper form, and it should always be preceded by its proper prefix. On the London, Chatham, and Dover Railway an express train was thrown off the rails, near Rainham station, and considerable damage done, though, fortunately, no lives were lost; this might have been entirely avoided if the station-master at Sittingbourne, who had been acquainted with the fact that there was something wrong by the driver of a previous goods train, had taken the ordinary precaution to write down a message and send it with the danger prefix. As it was, he simply told the clerk to warn Rainham of there being something wrong. Another station, seeing conversation going on, broke in with a message, produced delay, and the accident occurred. Most of the delays, inattention, and irregularities on railway circuits arise from this simple circumstance. On commercial circuits conversation is strictly prohibited. Everything that is sent or received is written down. If railway companies carried out the same rule, they would soon reap the benefit in greater despatch of business, prompter attention, and fewer errors.

On the West Midland, Shrewsbury and Hereford, and several other single lines in the West of England, the block system is fully carried out. But the needle instrument is used. There is also a speaking telegraph, by which the crossing places are altered, and irregularities dealt with.

There is no question that, when properly worked, single lines are sufficient to meet one-half of the requirements of the railway service of the country, where double lines at present exist. Millions and millions have been uselessly spent in the erection of double lines, where single lines would meet all the traffic. Parliament has compelled the London and South-Western Railway to double their line from Southampton to Dorchester. A single line would be ample for the traffic of that district. But single lines, until recently, have never been properly worked by telegraph. The telegraph was not understood. No reliable signalling apparatus had been introduced; delays arose. The public remonstrated, and shareholders' capital has been recklessly expended. With a reliable signalling apparatus to regulate the signals, with a well-managed speaking telegraph to regulate the trains, safety is assured, regularity obtained, and single lines become as secure and as rapid as double lines.

Even on double lines the telegraph, properly applied, becomes a great element of safety. As a secondary power it is invaluable. But railway managers are, to a great extent, prejudiced against its adoption. They don't use it, because they don't or will not understand it.

Captain Tyler says:—"Want of a proper system of working and using the telegraph, combined with the employment of unre-

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liable servants, or of servants with too much of other work to attend to, that has in like manner led to accidents in other cases—that has induced mistakes on the part of the men which would not otherwise have been made—that has afforded an excuse for not employing it—and that has prejudiced railway managers against it in a way materially to refuse its adoption and retard its progress; while the want of a really efficient code of regulations ready to be applied, and in which confidence can be placed, has also partly contributed to the same result."

Let them examine and study the telegraph, and they will find it a power in their hands to produce order and punctuality, security and speed, and, as a necessary consequence, prosperity and immunity from those dreadful disasters which have startled the public, proved such a serious loss to shareholders, and thrown so many happy families into misery, mourning, and grief.

MR. SHEPHERD'S ELECTRO-MAGNETIC CLOCKS.

THE following is a description of Mr. Shepherd's clock, which was so deservedly admired in the Exhibition of 1851:—

"The distinctive feature of Mr. Shepherd's electric clocks consists principally in the mode of giving impulse to the pendulum. In the electric clocks previously constructed, the pendulum at each vibration touched a metal stud in connection with a voltaic battery, and by that means communicated instantaneous but temporary magnetism to a coil of wire enclosed within the bob of the pendulum, and cause it to be attracted by a combination of permanent steel magnets placed within the sphere of attraction. The impulse to the pendulum was consequently derived from repeated magnetic attractions; and as voltaic batteries are constantly liable to variation, the movements of the clocks varied accordingly. In Mr. Shepherd's arrangement, the impulse is given to the pendulum by a spring, and the electro-magnetic power is employed only to relieve the pendulum from the action of the spring during the return of the vibration. By this means the impulse is altogether independent of the varying power of the battery, and the action is constantly the same. Another part of Mr. Shepherd's improvement consists in the mode of giving motion to the hands, which are made distinct from the pendulum, and thereby another cause of irregularity is avoided. The pendulum is, indeed, detached completely from the mechanism, its sole use being confined to regulate the passage of the electric currents. An ordinary second pendulum, of the size used in an eight day clock, is all that is necessary to put in action the largest electric clock, and a pendulum of that size was employed for working the great clock at the Exhibition of 1851, and all the other clocks in connection with it. The detachment of the different parts of the same clock from each other yet the connection that exists between separate clocks at considerable distances apart, constitute a remarkable feature of the invention. The pendulum may be hundreds of yards from the clocks it regulates, the striking parts may be placed as far off from the dial, yet the connection between twenty of such clocks is so intimate that they will all respond instantaneously to the vibration of a single pendulum, and move invariably together.

"The mechanism of the clock, above described, is fixed in the south gallery of the transept, at about 48 feet below the centre of the dial, sand motion is communicated to the hands by means of a rodmade up of several lengths of brass tubing screwed together, and of 1½ inch in diameter. The clock frame is much lighter than usual, as the ordinary heavy weights are entirely dispensed with. There are two wheels within the frame, placed vertically—the escape wheel, to which the power is applied, of 10 inches diameter, and a larger or central vertical wheel of 18 inches diameter, working into the pinion on the arbor of the escape wheel, which is in two parts, the teeth of each part being placed in opposite directions; on one part the click and rachet escapement acts, being moved by the electro-magnets, while the teeth of the other part are employed to lock the train, and prevent it running forward from the action of the wind on the hands. The large wheel revolves once in two hours, the spindle of which projects beyond the frame, and carries a bevel wheel of 12 inches diameter, placed vertically, which revolves with it. In order to give motion to the vertical rod already described, the bevelled vertical wheel works into a second bevelled wheel placed horizontally; and above the first, on the axis of the horizontal bevelled wheel, the vertical rod or shaft revolves; and by means of wheel-work at the top of the shaft, the hands of the clock are also made to revolve.

"The whole is kept in motion by a series of powerful electro-magnets, eight in number, on which is wound a total length of 25,000 feet of copper wire, of the size usually denominated "No. 18, Birmingham wire gauge," the weight of the wire being nearly 1½ cwt. Six small batteries of Smee's construction are used in connection with the electro-magnets. Mr. Shepherd prefers Smee's battery to any other, on account of its simplicity, and the ease with which it is recharged when required. —*Routledge's Guide.*

MORAL CAUSES.

MR. G. P. BIDDER AT THE INSTITUTION OF CIVIL ENGINEERS.

[Concluded from page 201.]

Upon this there followed a Treasury Minute, dated Aug. 4, 1858:—

"Inform Messrs. Glass, Elliot, and Company, that my Lords have made an arrangement with the Red Sea Telegraph Company, by which, on certain conditions, a guarantee on the part of Her Majesty's Government is granted to that Company.

"It is one of the conditions in the arrangement, that the line of telegraph shall be laid down on the responsibility of the Company; my Lords do not propose to interfere in the selection of the parties who are to execute the work, further than to see that its proper execution is sufficiently secured. My Lords have no doubt that the Company will adopt the proper means of procuring contracts for the execution of the work on the best terms, and can only refer Messrs. Glass, Elliot, and Company, to the directors of the company."

The first of these documents proceeded from rival manufacturers who might have been impelled by hostile feelings; but no public contradiction, or explanation, had ever been offered of the facts alleged.

On the 27th of August, 1858, the Chairman of the Board of the Red Sea Telegraph Company, in a letter to the Treasury, said:—"As regards the selection of Contractors, they [the directors] beg to state, that the choice lay between two firms, and that, in a matter of so much importance, and with so limited a number of competitors, it appeared to them, that the early and satisfactory completion of the enterprise would be most effectually promoted by the selection of the contractors who combined the highest reputation, with the largest experience in laying submarine cables. The reputation of Messrs. Newall and Co. stood preeminent, and they had already succeeded in laying several telegraph lines."

Inclosed in this letter was "A Memorandum of Agreement made and entered into between the Red Sea and Indian Telegraph Company, of the one part, and Robert Stirling Newall, Charles Liddell, and Lewis Dunbar Brodie Gordon, all of Abingdon Street, Westminster, trading under the firm of Newall and Co., of the other part," covenanting, that "the said Messrs. Newall and Co. shall manufacture and lay down 'the cable' from Suez to Aden, and, if the Board should require it, and announce their desire to that effect, within four weeks from the day hereof [left blank in the Blue Book], from Aden to Kurrachee, at their own risk and responsibility, and deliver 'the cable' complete, and in full working order and condition, for the sum following, viz.:—

"From Suez to Aden, for the sum of £225,000;

"From Aden to Kurrachee, for the additional sum of £246,425.

"The Board are to have the right of inspecting the cable and materials during manufacture and while laying, by their own members, and by their officers, and persons appointed by them, in such manner and at such times as they may think fit."

On the 23rd of September, 1858, Mr. J. Cosmo Melville wrote:—

"With regard to the proposed arrangements for executing the work, Lord Stanley is not aware of the reasons which induced the directors of the [Red Sea] Telegraph Company, to enter into a contract for the cable, without resorting to the system of competition; and he does not perceive why that principle could not have been advantageously applied in this case, or why both the firms engaged in the manufacture of the cable, which the directors appear to have taken for their model, should not have had the opportunity of making a tender.

"With regard to the description of cable which has been fixed upon, Lord Stanley is inclined to urge, that every precaution should be taken to secure the best that can be devised for the purpose. It is well known, that grave doubts are entertained by some authorities, as to whether the Atlantic cable meets all the requirements of a submarine telegraph work, and he would suggest, therefore, the desirableness of obtaining the concurrent opinion of two or more eminent authorities upon the subject, before making final arrangements.

"Having perused the proposed agreement with the contractors, the only observations with regard to its terms which I am desired to make, are, that it would be desirable to modify the first clause so as to oblige the contractors to keep 'the cable' in working order for one month, at least, from the date of the first message passing through it; and that

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Clause IV. should be made quite clear upon the power of the Telegraph Company to test, as well as inspect, the cable and its component parts, in all stages of its manufacture."

This letter must be borne in mind, as it related to the important points of the contract being given without competition,—the form of the cable, referring to the "grave doubts" entertained with respect to the Atlantic cable, which, at that period, had virtually failed,—and the obligation to be imposed on the contractor to keep "the cable" in working order for one month at least, from the date of the first message passing through it, the original proposed period of maintenance being only ten days.

It should be observed that, up to this point, no mention was made of the testing, or of the reception of 'sections' of the cable; but 'the cable,' meaning the whole extent of the cable from Suez to Kurrachee, was evidently intended by the Government and by the Red Sea Telegraph Company.

In the letter of the 28th of September, 1858, from the Chairman of the Red Sea Telegraph Company to the Treasury, after repeating the former reasons for giving the contract to Messrs. Newall and Co., it was stated;—"But it was also supported by the consideration, that the firman from the Turkish authorities, which was the basis of their operations, would lapse, unless the telegraph was established between Constantinople and Alexandria, before the end of the present year (1858); and that Messrs. Newall and Co. engaged, on receiving the Red Sea contract, to complete that telegraphic communication from their own resources in time to save the Turkish concession.

Now it must be observed, that up to the present time (1861), no communication between Constantinople and Alexandria had ever been made; yet that was one of the chief reasons for not submitting the contract to public competition.

In that same letter it was said:—"The Board have communicated to the contractors the desire of Lord Stanley, that the period for which they should be bound to maintain 'the cable' in working order, be extended from ten to thirty days, and they hope to be able to effect the arrangement."

In the contract with Messrs. R. S. Newall and Co., dated October 23, 1858, it was stipulated that they "shall manufacture and lay down 'the cable,' from Suez to Kurrachee, at their own risk and responsibility, and deliver over the same to the Company, complete, in full working order, and in condition to transmit ten words per minute."

In Clause V. of this contract, which stipulated for certain payments being made to the contractors as the work proceeded, it was said:—"And no part of the money is to be considered as due until the cable, 'for each section,' shall have been efficiently at work, as hereinbefore specified, for one clear calender month, &c.

"Any surplus cable remaining, after the final completion of the contract, is to belong to the parties of the second part [the contractors]."

These documents exhibited, prominently, the duty of an engineer, to exercise great care in drawing up a contract, as well as to see all the provisions scrupulously carried out.

It would be observed that, whereas the tender of Messrs. Glass, Elliot, and Co. was £460,000, that of Messrs. Newall and Co. was £471,425; yet the general result involved in the tender of the former firm was evaded. It must be borne in mind, also, that Messrs. Glass, Elliot, and Co. had stated in their first letter to the Treasury, that they had examined the estimates, and were prepared to execute the same work for £100,000 less. This, however, was entirely overlooked by the Directors, who only said they considered the question of £10,000 was immaterial, because they had received an undertaking from Messrs. Newall and Co. to complete the cable from Constantinople to Alexandria, and thus to connect India with Europe; which, however, was not even yet accomplished. It was to be remarked, however, that no formal undertaking, on the part of Messrs Newall and Co., to complete this communication, appeared in the official papers.

These details might appear prolix, but it was impossible, otherwise, to lay clearly before the meeting, even an outline of the case, and still less to give a notion of the causes which had led to that lamentable failure.

In the contract, Clause IV., it was provided, that the Board itself, or by its officers, were to have the right of inspecting and testing the cable, as well as all the materials, during manufacture, and whilst being laid, but not so as to interfere with the process of manufacture. But as regarded the laying, the meeting had been told by one of the engineers of the Company, that they never had any responsibility, as they never were permitted to interfere with the laying of the cable.

Another condition of the contract was, that the estimates allowed 20 per cent of extra length, in order that the cable might be laid sufficiently slack. Another clause, however, gave to the Contractors all such portions of the extra length as were not actually laid; thus actually offering a premium for laying the cable as "taut" as possible. The obvious result was, that in consequence of the engineers not having any authority to interfere with the mode of submerging, the cable was laid with so little slack, that failures declared themselves almost immediately; and, eventually, a vessel was engaged, during 182 days, in abortive attempts to repair 184 miles of cable.

It was evident that a contract had been made which absolved all parties from responsibility. The engineers had no power of interference, and the liability of the contractors was restricted to thirty days. Even here, however, there was an ambiguity; the Government demanded that "the cable," meaning the entire cable, should be kept in perfect working order, during thirty days at least; but in dealing with the contractors the Company apparently omitted to insist upon this condition, as although it was admitted, that each of the subdivisions of the cable, when laid, had conveyed messages during the minimum period, yet no messages had ever travelled throughout the line (beyond one or two days), according to the evident intention and provision of the Government, and on the faith of which a guarantee had been granted. It had recently been stated that Messrs. Newall and Co. declined to enter into the contract, if they were held to the maintenance of the entire line for thirty days. The question appeared to have been settled by a compromise between the Company and the contractors, and the public was saddled with the payment of nearly £36,000 per annum: whilst, probably, all the work would have to be done over again, as the present cable, now lodged on the bottom of the Red Sea, was of no earthly utility, save to the zoophytes, which, no doubt, were closely attached to it.

Now as to the Rangoon cable. The Government requested the opinion of the late Mr, Robert Stephenson upon the form of a cable to be laid between England and Gibraltar, and the suitable construction was pointed out. This recommendation was reported upon by the engineer, who was appointed to the project. It was, however, imagined that the line might be interfered with, in case of hostilities, and this cable, which was originally designed for a deep-sea line, was now ordered to be transferred to Rangoon, to be laid between that place and Singapore, a considerable portion of which route was through comparatively shallow water. The next that was heard of this unhappy cable was, that it was in a state of fermentation; whether from the hemp covering, or from the oxidation of the iron, was not stated. But its destination had been again changed, and it was now, apparently, to be transferred to the station between Malta and Alexandria, to supersede the cable for establishing a communication between Constantinople and Alexandria, which Messrs. Newall and Co. had undertaken to lay, but which had not yet been completed. The statements of the Blue Books on this subject were curious, and deserved careful attention. As to the construction of the cable, it appeared to be of superior character, and it was a matter of regret that it had not been laid in the place for which it was originally designed.

It was evident, that there were in electric telegraphy, other considerations beyond scientific knowledge and mechanical skill, and those who had to deal with the subject, must be prepared to cope with difficulties arising from other and far different causes. An instance in point, was the accident which had recently happened to a line laid between England and the Continent, for the International Telegraph Company. The cable contained four conducting wires, and whilst it was coiled, the whole acted perfectly, but when it was laid, only three of the wires were found to be capable of performing their duty. The Directors, unlike the Government, had bound the contractors to lay a perfect cable; they refused therefore to receive it in that condition. The contractors expended a large sum in ineffectual attempts to raise the cable, and to discover the cause of the failure, during a stormy season. On the return of propitious weather, they were more successful, and they then discovered that a nail had been skilfully inserted in the cable, in such a manner as to destroy the action of one wire. A person who had been on board during the submersion of the cable, at length confessed that he had been the pay of other parties; that, at their instigation, he had sought for employment under the contractors, and had, under instruction, inserted the nail. As the case would very shortly be brought before a court of ustice, it would be improper to enter into further particulars, but the occurence justified the severe remarks as to "moral causes," that had been made during the discussion.

The most important part of this question, was the necessity of taking the proper steps for insuring a satisfactory submarine telegraphic communication. Several of the deep-sea Mediterranean lines had failed from mechanical causes, some of which had been foretold, before the submersion of the cables had been attempted. This de-

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monstrated the necessity for more careful and accurate surveys of the bottom of the ocean, to the depth of 500 fathoms, or 600 fathoms on the lines where cables were to be laid.

Although it was essential, that a proper route should be selected it was not requisite to have the entire bottom of the sea mapped out with the great accuracy which had sometimes been contended for, as it would involve too great an expense. Experience had shown that the destruction from mechanical abrasion, only took place within limited depths; the more elaborate survey might, therefore, be restricted to practical depths, and in shallow waters it should be minute. Within soundings, the cable should be strong, and heavy, but a smaller section might be used beyond. At all events if that plan was adopted for the cable between England and Gibraltar, there would be little fear of damage from hostile disturbance. He suggested that an instrument might be devised which would indicate, with sufficient accuracy, the general character of the bed of the ocean, upon a plan similar to that adopted for measuring the rise and fall of tides, the record being made by the passage of a pencil over a sheet of paper moved by clockwork.

Corrosion could not be prevented, especially where the cable reposed upon sand; but, commercially, that difficulty could be met by making a provision for renewal, at intervals, say of seven, or eight years. So serious an element in the cost of submarine cables, was their liability to corrosion, that in the cables of the Electric Telegraph Company, the depreciation arising from this cause alone, was estimated at £8,000 per annum.

A main point was the form of contract which the Government should enter into with parties offering to lay down cables. It appeared, that at present few, if any, of the submarine telegraphs were remunerative *per se;* and with the failures of the Atlantic and Red Sea cables as precedents, companies would scarcely be found to embark in such undertakings, without some Government assistance. Then came the question of the terms upon which the Government might safely enter into such engagements. After considering all that had been done up to the present time as described in the Blue Books, it appeared that the safe course would be to negotiate only with such contractors as were known to be responsible and trustworthy, to pay them a sum not exceeding the actual cost of the cable, and then to covenant to pay a liberal per centage for the use of the cable for the period during which it actually remained in working order. The amount paid for effective service was a minor consideration, when compared with the arrangement by which the country had been saddled with an annual payment of nearly £36,000, without the chance of deriving any practical benefit.

He believed that the free discussions of the subject in this Institution, would materially aid the progress of submarine telegraphy, and would, eventually, enable engineers to proceed with the same certainty as to the result, which was attached to the other branches of civil engineering. He also hoped that the expression of opinion which had been elicited, would lead, elsewhere, to a more practical consideration of the question, than it had hitherto received.

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.	
Para	1s. 11d. to 2s. per lb.
Negro Head	1s. 1d. to 1s. 3d. „
Java	1s. 4d. „
GUTTA PERCHA	
Fine	2s. 4d. to 2s. 6d. per lb.
Genuine Mixed	1s. 9d. to 1s. 11d. „
Low Ordinary Reboiled	10d. „

September 3, 1862. WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

THE PROGRESS OF TELEGRAPHY.

WE insert this week an account of the successful submersion of a telegraph cable between Lowestoft and Zandvoort, the property of the Electric and International Telegraph Company. The cores of this cable were manufactured by the Gutta Percha Company, and the sheathing applied by Messrs. Glass, Elliot, and Co. Its enormous weight and size appear to have presented but little difficulty in the operation of "paying out." This is the second cable laid for the above company within the last twelve months.

In our last number, we briefly referred to another cable—a pioneer—about to be submerged for the Government of India. This cable is twenty miles in length. The conductor consists of a strand of seven copper wires of the purest description, insulated, in the first instance, with a coating of virgin rubber, then with a number of coatings of masticated rubber. It is served with the best Russian hemp, saturated with pure Stockholm tar, then furnished with twelve No. 8 galvanized iron wire. The shore ends, four miles in length, are covered with twelve No. 1 galvanized iron wire, tapered down to the size of the main cable. No difficulty whatever was experienced in the process of sheathing; the firmness of the core being equal to that of gutta percha. In many respects, indeed, it was found less liable than gutta percha to be injured in the operation of sheathing. The core, as soon as completed at the manufactory of the patentees (Messrs. Hall and Wells), was subjected to hydraulic pressure for electrical purposes, the tests, which were considered exceedingly satisfactory, being conducted under the supervision of Dr. Green, a gentleman well known in connection with our great Indian telegraph system. The core was then transferred to Mr. W. T. Henley's works at North Woolwich, to receive its sheathing, &c., after which it was subjected to further electrical tests of a very stringent character, in which a most sensitive galvanometer was employed. The loss of insulation upon the cable, as indicated upon the instrument, was exceedingly small, not more than 7° upon sixteen miles. The inductive discharge, upon sixteen miles with two cells (of Daniell's), was 9°; with four cells, 23°; and with six cells, 45°. Assuming that the delicacy of the instrument employed was equal to that supplied by Mr. Henley for the late Government experiments, the small amount of retardation, as above given, proves that it is a well designed and manufactured cable, when compared with the results of induction tests recorded in the Blue Book. Several tests were made by working through Morse's printing and Mr. Henley's alphabetical telegraphs, all of which being considered highly satisfactory. The cable is to be submerged between the main land and an island in the Persian Gulf, with a view ultimately, we believe, of considerably extending the line.

Great interest is felt in the success of the undertaking, as it is an effort to introduce india rubber for the purpose of submarine telegraphy in latitudes where high temperature has proved fatal to other materials. Sir W. O. S. Brooke, F.R.S., who is now on a visit to England upon leave of absence from ill health, impressed with the vast advantages which would accrue from the establishment of a line of telegraphy between England and India, has determined to grapple with the difficulties which have hitherto foiled our attempts in the Indian seas, and we sincerely trust that his efforts in this, like those in the development of the gigantic system of telegraphy in India, will be crowned with success.

Telegraphic News.

TELEGRAPHIC PROGRESS.

IN a previous number we published a short account of the successful submersion of the Lowestoft and Zandvoort cable, the property of the Electric and International Telegraph Company; we have now been favoured by a correspondent with the following brief description of the cable, and an account of the expedition, which we now insert.

Length of cable as laid, one hundred and ten knots. Length of shore end, thirteen knots. Length of deep sea portion, ninety-seven knots. Weight of shore end, twenty tons per knot. Weight of deep sea portion, ten and a half tons per knot.

The cable contains four conducting wires, weighing each one hundred and twenty-eight pounds per knot, covered with three layers of gutta percha, and three of Chatterton's compound; in all six layers.

The shore ends are of a peculiar and novel construction designed by Mr. Cromwell F. Varley, consisting of the four conducting wires served with tarred hemp, overlaid by fifteen No. 5½ B. W. G. iron wires. These are again covered with tarred yarn, and afterwards

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overlaid with twelve strands of iron wires, each strand consisting of three iron wires, No. 5½ guage, twisted together, in all 51 iron wires.

The ends are lastly covered with tarred yarn, making a total diameter of nearly 2¾ inches; the deep sea portion having a diameter of one and a half inches.

The shore ends are extremely flexible, and were designed to resist the effects of ship's anchors.

The ordinary form of cable when hooked by a ship's anchor in a gale of wind, and under-run is frequently stripped, by the breaking of a wire, for a hundred yards or more.

The present cable, if a wire break, can only be stripped two inches, *i.e.* the length of the lay of the strand.

These bulky shore ends ran out with the greatest ease without any indication of, or approach to a kink. The deep sea portion is covered with ten No. 00, guage iron wires and though much less in diameter and weight was much more rigid and liable to kink. The perfection of Messrs. Glass Elliot and Co's. machinery, combined with the skill, and last but not least, the great courage of their highly efficient and experienced staff, prevented the cable from indulging in kinks, although it showed on one or two instances strong inclination to make them. On these occasions Mr. Windle and his staff seized hold of the rigid ocean monster, and compelled it at the peril of their lives to straighten itself.

Prior to laying the cable, it had been arranged between Captain James Blackblock of the *Monarch*, and the Electrician of the Electric and International Telegraph Company, to buoy the course throughout.

Accordingly the *Monarch* Steamer was despatched on this most important service, which has ended in laying the cable in a straight line, in saving two thousand pounds worth of cable, and in shortening it by five knots, and, what is very important, the longitude and latitude of this cable are known exactly. Should any repairs be necessary, which is not likely for the next twenty years to come, the cable can be found in a very short space of time.

The landing of this cable on the Dutch side was performed by means of a Dutch schuyt, the only form of vessel capable of landing in all weathers on this dangerous coast.

It was laid by Mr. Samuel Canning and Mr. Henry Clifford, being tested by Messrs. De Sauty and Sanders, on behalf of Messrs. Glass, Elliot and Co., and on behalf of the Electric Telegraph Company by Mr. Cromwell F. Varley, Electrician of the Electric Telegraph Company, accompanied by Mr. H. Winter and Mr. H. Sache, to assist in testing the cable, and Captain James Blacklock to direct the course.

On shore the end of the cable was placed in a bathing machine hired for the occasion, where Mr. Bull, on behalf of Glass, Elliot, and Co., and Mr. J. Graves on behalf of the Electric and International Telegraph Company, watched the cable. They had all the necessary instruments for testing, and for conversing, and when the first half was laid, above a dozen messages from mid-ocean was sent by the lightning flash to different portions of the British Isles and elsewhere, announcing the satisfactory laying of the first section of the cable, and the probable time of the arrival home of those engaged in this world civilizing undertaking.

It was laid in two sections, as it was not easy to find a steamer capable of carrying the whole of so heavy a cable. The steamer *Hawthorns* which conveyed it, was commanded, for the occasion, by Captain Donaldson, of the *William Cory*, who has pioneered more successful cables than any one else. When the cable had been landed, and finally tested, it was found to be more perfect than any cable hitherto laid—the Abermawr Bay and Wexford cable perhaps excepted; and when all concerned in the operation returned on board the *Hawthorns*, where dinner was awaiting them, the sparkling hock and champagne was unnecessary to elicit the overflowing satisfaction of every one who had taken part in the operation. The landing of the cable, at the little watering place, Zandvoort, created quite a gala there, fireworks were let off in honour of the occasion, which were promptly answered by the guns of the *Hawthorns*, and with rockets and blue-lights, in which latter the *Monarch* outdid the *Hawthorns*.

THE TELEGRAPH ROUTE TO INDIA.

MAJOR STEWART has returned from his conference with the Persian authorities, relative to the passage of the electric wire passing from Bagdad to Kurrachee. It is announced that insuperable diplomatic difficulties exist in carrying the line as intended by Teheran and Ispahan. It is now proposed to carry the line from Bagdad to Ali, lying west of the Euphrates, and thence to the gulf, where it can be submarined to Kurrachee. But our readers will be aware that this is only one of three routes proposed, and that Government is sorely perplexed in arriving at a decision on the subject.

THE UNIVERSAL PRIVATE TELEGRAPH COMPANY.

WHEATSTONE *v.* WILDE.

WE have been informed that the arbitrator appointed in the above important case, has decided that the instrument of the defendant (Wilde) is not an infringement of that of the plaintiff (Wheatstone). We hope in our next number to be able to give full particulars of this long pending case.

REPORT OF THE DIRECTORS OF THE SUBMARINE TELEGRAPH COMPANY.

AT the last half-yearly meeting of the Shareholders, it was resolved, at the recommendation of the board :—

> "To adjourn the consideration of the accounts, until after the completion of the investigation, then being made into the financial position of the Company."

That thorough investigation has terminated, and the accounts now furnished to the Shareholders, will be found perfectly clear and explicit, and fully justify the Directors in the confidence which they have always expressed in the great resources and value of the property.

These accounts, ending 30th June, 1862, contain the receipts and expenditure of the past twelve months (instead of the usual half-yearly statement), and when compared with those of the previous year, exhibit an increase of £1,330 16s. in receipts, notwithstanding the reduction of nearly 50 per cent. upon the tariff.

It is satisfactory to the Directors to be able to state, that this increase of business is progressive, as during the six months, ending 30th of June last, 137,714 messages were transmitted over the Company's wires, against 127,163 during the previous half-year, giving an increase in money of £1,398 4s. whilst the working expenses have been reduced.

The returns of the current half-year are still more favourable; the number of messages carried during the past seven weeks being 44,985, or an excess of 14,015, over the same period in 1861, while the increase in money amounts to £1,717 12s. 7d.

The inaccuracies in the former accounts, alluded to in the last report, have been carefully analysed, and the result shows a balance of £5,591 16s. 11d. against this Company, a portion of which ought to have formed a charge against the revenue of former years.

As the Directors do not consider it equitable, that the whole of this amount should be charged upon the earnings of the last twelve months, they have, in conformity with their previous recommendation, opened a suspense account, which will leave £2,300 15s. 11½d. to be carried forward and paid out of future revenue.

The earnings of the Company, after paying the working expenses and repairs of cables, the interest on debentures and loans, and deducting 10 per cent. on gross receipts, for a reserve fund, leave a sum of £3,799 6s. 2d., equivalent to a dividend of 3 per cent. per annum for the last half-year, with a balance of £620 5s. 9d. to be carried to the credit of the next account.

The repairs to the cables, although heavy, have been less by about £2,000, than in the previous year; and, at the present moment, the Directors have great pleasure in stating that all the lines are in good working order, and the French Government, being satisfied with the condition and efficient working of the Dieppe cable, have refunded to the Company the caution money they had retained to guarantee the due performance of the terms of the concession in that respect.

The British and Irish Magnetic Company, with whose lines the wires of the submarine cables are united, have extended their system to Bristol and the South West District of England and Wales, from whence a considerable Continental traffic is expected, and negotiations are pending with that Company for a modification of the tariff arrangements, so as to secure to this Company a more adequate portion of profit for the much greater risk incurred by submarine lines.

The traffic from the Mediterranean and India is also likely to improve, as the Italian Government are about laying down a submarine cable between the Southernmost point of Sardinia and Marsala, so that the long delays which occur to telegrams, while being transmitted over the Central Italian lines will be avoided.

The following resolutions were then adopted :—

1st. That the report and accounts now read, be received and adopted.

2nd. That in accordance with the recommendation of the Court of Directors, a dividend for the half-year ending the 30th of June, 1862, at the rate of 3 per cent. per annum, less income tax, be declared, and that it become payable on, and after the 12th of September next.

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3rd. That Captain John Grant, John Watkins Brett, and Francis Edwards, Esqs., who retire, pursuant to the deed of settlement, be re-elected Directors.

4th. That G. Copeland Capper, and Wm. Cole, Esqs, and Mr. Alderman Dakin, who retire, pursuant to the deed of settlement, be re-elected Auditors.

5th. That the thanks of this meeting, be given to Sir James Carmichael, for his conduct in the chair, and to the Directors, for their attention to the interests of the Company.

L. Walter Courtenay, *Secretary*.

58, *Threadneedle Street, London*, 21*st August*, 1862.

[Owing to the want of space, the balance sheet is deferred to next week.—Ed. E.]

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic, A.	100	50 to 54 x.d.	———
20	Do. B 7 per cent. till 1862 .	all	19 to 21	———
20	Do. C	all	———	———
Stock	Electric Telegraph . .	100	98 to 102	———
25	Do. New	20	———	———
5	London District Telegraph .	4¾	4¼ to 3¾ dis.	———
10	Lond. & S. Ireld. Direct Tel.	2	——— pm.	———
10	Mediterranean Extension Tel.	all	3½ to 4½	———
10	Do. 8 per cent. pref. . .	all	———	———
1	Submarine Telegraph, scrip.	all	⅜ to ⅝ x.d.	———
1	Do. registered . . .	all	⅜ to ⅝	———
10	Do. " . . .	all	4 to 6	———
2	Telegraph to India . .	1	⅝ to ⅜ dis.	———
5	United Kingdom Telegraph .	3	½ dis. to par.	———

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

PROFESSOR THOMPSON'S PATENT MARINE GALVANOMETER.

To the Editor of The Electrician.

Sir,—I have been lately informed that one of the above galvanometers was sent by Professor Thompson for the use of the late Experimental Committee of the Board of Trade, and that it remained *unemployed* at the Works for weeks; at least, its existence is not mentioned in the reports of the experiments. It appears, however, that Mr. Henley's galvanometers were in daily requisition, and Mr. Latimer Clark bears testimony to their excellence. One of these galvanometers is exhibited at the International Exhibition, but its existence is ignored, it has not even been "Honourably Mentioned," while a "Medal" is granted for that which was unemployed.—Yours, &c.,

Fair Play.

September 1*st*, 1862.

Sir,—Your correspondent, "J. King," wishes to know how to make varnished paper. I have made some very good with wax or spermaceti, and then varnished with shellac, dissolved in spirits of naphtha, the wax is broken into small pieces and spread on the paper, and then smoothed over with a common hot iron, the wax will flow evenly over the paper, which will be perfectly saturated and become nearly transparent, when the wax has set it may be easily varnished, varnishing only *one* side at a time, and by the time the last one is varnished the others will be sufficiently dry to commence varnishing the other sides; they dry very quickly by hanging on a line, and when finished are very pliable.—Yours truly,

J. Cook.

THE AWARDS, CLASS XIII.

To the Editor of The Electrician.

Sir,—In your Journal of the 23rd inst. you state:—"We have the greatest possible regard for Professor Thompson's mathematical abilities; but we must protest against the granting of a medal to a manufacturer simply employed by him to construct his instruments." His mathematics may be great, but what of his logic? He (as a Juror) gives to Mr. White a medal, for what? the perfection of manufacture, not for originality of invention, or any improvement, or progressive step in applied science; if that be the merit for which the award is made, then it appears on the face of it that the Jurors of Class XIII., of which Professor Thompson is one, ignore any originality of invention, and consequently any merit for the so-called "Thompson's Patent Marine Galvanometer," &c., &c. Is it possible the Jurors have discovered in this instance that there is nothing new under the sun? It appears to me that the fact of the award as it stands is one thing in plain English, and the reasons for it quite another, and, inconsistent with the fact, unless the "Novelty of Invention" belongs to White and not to Thompson *or any other man*.—I am, sir,

London, August 27, 1862. Observer.

P.S. I have a curiosity to know something of Mr. Varley's invention, that has got a medal but never has been exhibited, can *you* describe it and enlighten those who are in the dark as to the mythical principles of the learned Jurors of 1862 in granting awards.

To the Editor of The Electrician.

Sir,—"A Practical Electrician" is disposed to be facetious, rather apparently at the expense of your very humble servant, but really and unwittingly he is the butt of his own joke.

For to any one uninitiated—your younger readers for instance, whom your correspondent is doubtless very anxious should have correct ideas upon the subject—he would convey the notion that that is the most perfect insulator, which is wanting in one of the fundamental elements of proficiency. Happily, he who runs, may read this matter, and a blind man, though a fool, cannot have erred if he have arrived at the conclusion that induction is by no means desirable in an insulator, and that therefore, that material is the best for the purpose which shows the least amount, providing it is suitable in every other respect.

For myself I lay no claim to being a practical electrician. I am an exceedingly modest individual, and never boast of my attainments, perhaps I have none to boast of—not at all unlikely by the bye—some people, (kind friends no doubt) say this excessive modesty is a disadvantage to me, and upon my word I believe it is, for if I were to persist in reiterating a sufficient number of times that I was this that and the other, the world would at length give me full credit, and endorse the assertion magnificently. But I fear it cannot be done; nevertheless, there are times when even the most bashful and retiring must needs stand forth and insist that they are in full possession of their senses.

Your generous correspondent is kind enough to say, in plain terms, that I know nothing of the subject which formed the burden of my last letter—lucubration I think he calls it, (much obliged, that will do very well, for I burnt one candle, value three-eights of a penny, over it), I trust he will not take it amiss, however, if I say that that is a school-boy style of argumentation which is hardly becoming "A Practical Electrician," and yet why not! those school days were glorious times, barring the birch, and one can linger over them fondly, and treasure up not only the remembrances, but our very forms of expression, and I say perish the fellow who can forget them.—Well, well, we'll leave that; this is not the *Cornhill Magazine*, nor am I W. M. P., I wish I were.

The whole matter of my last turned upon this point—What is perfect insulation: (?) and inductive capacity comes in only as a secondary part of the subject, inasmuch as in a greater or less degree it is a quality which characterises all insulating materials.

I stated my opinion as to what constituted perfectness of insulation, a low inductive capacity being one of the essentials, in so far as it could be obtained compatible with other imperative requisites of a good insulator, and my opinion as therein given is a logical sequence of the premises laid down. Shall I illustrate what I mean by inductive capacity? Here are two materials used for insulating purposes: the one under given circumstances—say under Reid's pressure test for instance—with a given thickness of dielectric and a given length of wire, shows an inductive discharge of two degrees, this is what I call a low inductive capacity.

The other, under the same circumstances, with same length of wire and thickness of dielectric, shows an inductive discharge of 6 degrees—this is what I call, relatively to the other, "high inductive capacity." "A Practical Electrician" wishes to know what I "really imagined inductive capacity to be," and I am sure he ought to be very much obliged to me for making myself so intelligible on the matter, and without being vain-glorious myself, I could wish he were as explicit in some things. I will not say take a leaf out of my book, because candidly, speaking, it would make me blush uncomfortably.

The question, what constitutes perfectness of insulation? is an open one, and a "Practical Electrician's" ideas upon the matter may be the very opposite of mine: but this is really the question at issue. Why did not your correspondent favour us with his notions on the subject: it would have been more to the purpose than to quibble about a doctrine which even the doctors could not decide for themselves. Ah! I fear he is one of those misanthropical gentlemen, who could, if he chose, let us into no end of secrets, but he does not think we are worth the trouble; and it is just possible his estimation of us is not far wrong.

But what can a novice make of the text? "Generally speaking, the more perfect the insulating property of the material is, the less is its inductive capacity." The first question that suggests itself is the oft-repeated one—what constitutes perfectness of insulation? and this decided, the rest is easily arrived at. But here is the sticker; evidently the Government Committee themselves were at sea upon the point; and yet, if left undecided, the proposition is meaningless, and can only tend to bewilder the reader. This was my view of the matter, and hence I intended to answer the query; I may not have been successful in the endeavour, although I gave my conscientious convictions upon the point, from which, at present, I see no reason to swerve. Perhaps if a "Practrical Electrician" would comply with my invitation, we should be able to arrive at something like a solution of a very interesting question.

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In my remarks upon this point, I was treating of insulation only so far as practically applicable to submarine cables, and not to insulators or non-conductors generally; that being the case, therefore, it is foreign to the purpose to dwell upon the qualities of spermaceti, or glass, or shellac, or bees'-wax, or any other fine material which is useless for practical purposes in the way mentioned. Aud here I may as well make a clean breast of it, and confess that "A Practical Electrician" knows more of these things than I do; I am ashamed of my ignorance, but then I am humble, kind friends, and apt to learn; stay, not so fast; there is a gentleman in question who thinks otherwise, and oh, dear me! I fear I *am* irremediably obtuse. Notwithstanding, however, I will pluck up and say that my opponent has utterly mistaken my position, since he launches forth into the whole catalogue of non-conductors and their inductive capacities, with which I have nothing whatever to do. The position I took up was perfectly simple, and ought not to have been taken up by "A Practical Electrician." As it is, however, he will be pleased to submit with as good a grace as possible while I faintly smile, for which I solicit permission.

In confirmation of my doctrine, that "*the more perfect the insulating material is, the less is its inductive capacity,*" I can refer "A Practical Electrician" to the evidence and report of Mr. Latimer Clarke, and also to Mr. Varley (Blue Book), and others. As I said before, all turns upon the point of "perfect insulation," and that cannot be considered so which shows a high inductive capacity; nor can any material which lacks any quality, no matter how trifling, that unfits it for submarine purposes.

Well, now I would beg to ask "A Practical Electrician" if he is practical enough to adopt spermaceti, or glass, or shellac, or sulphur, or bees-wax, or resin, or any other similar non-conducting substance, to the efficient insulation of submarine cables, either separately or combined; and if he cannot, I would further ask, in the name of common sense, what is the meaning of his letter, and what possible application can it have to the question at issue; but here I may observe, that if my perceptive faculties be blunted, that will account for my not being able to see through a stone wall; and my readers will compassionate me accordingly. But even supposing my friend's practical abilities would enable him to concoct an insulator out of such chaotic materials adopted for the purpose; still, if his compound were to show the same characteristic of high inductive capacity as the materials do individually, I should eschew the conglomeration as wanting in the main element of a perfect insulator. My former argument went to show that that material only could be deemed a perfect, or proficient insulator, which possessed every requisite quality, from the most essential down to the most trifling, adapting it to all the multifarious and singular requirements of a submarine cable; and, that as low an inductive capacity as possible was no less desirable than homogeneity, toughness, elasticity, &c. Now does "A Practical Electrician" mean to say that the reverse of all this is the thing to be aimed at—that high inductive capacity (as I understand it) is necessary in order to perfect insulation?

I had imagined all along that electricians and telegraph engineers aimed at effecting immediate communication through insulated conductors with as little waste of electricity as possible, and that none at all would, in their estimation, be still better; such is evidently the conclusion one must arrive at, whether he study the pages of a Government Report, the Electrician, or the dictates of common sense. Waste by leakage we know is not to be tolerated, and by induction—the doctrine is, "what can't be cured must be endured," but let us have as little of it as possible.

I cannot, therefore, follow "A Practical Electrician" in his graduated scale of perfect insulation, which, the more perfect they get the higher inductive capacity they show; I deny that such substances are even to be deemed passable, certainly never good; and as to perfect, that is simply out of the question (that is, as I understand the term).

Yes, just so; as I understand the term: and "inductive capacity" seems to mean the same in Mr. Varley's vocabulary as it does in mine. It may not, however; and I may not have the "slightest acquaintance with the subject;" I should not be surprised if it were so; probably I am, electrically and telegraphically speaking, in a shockingly benighted condition; and so I claim the forbearance of your readers, and throw myself on the magnanimous clemency of your correspondent, "A Practical Electrician."

Amicus.

Miscellanea.

Firing Cannon by Electricity.—A letter from the camp of Chalons, dated Wednesday last, states that the Emperor assisted that day at the experiment of firing cannon by electricity. This new mode of firing cannon is called electro-telegraphic, and has been practised at the camp for the last two months, in presence of commissioners selected from the superior officers of artillery. The following is an explanation of the new system. When the firing takes place at a distance of 2,000 or 3,000 metres from the object to the struck, it requires a certain time to ascertain the accuracy of the aim. With the system at present under trial at the camp, the indication of the accuracy of the aim is instantaneous, and, if imperfect, it may be instantly rectified. The Emperor arrived at the practice ground at twelve o'clock. He was accompanied by Marshals Canrobert and M'Mahon, Generals Lebœuf, Courtois d'Hurbal, l'Admirault, and Alexandre, and by two Russian officers of artillery, who were permitted to witness the experiments. On the arrival of the Emperor the firing commenced, and the experiment proved most successful. The target, formed of planks placed at a considerable distance, was literally riddled with grape-shot. The indication of the precision of the aim was made with great accuracy.

Electricity has been the careful study of the most eminent men in Europe and America for upwards of a century; to enumerate their names would fill a page; yet the most eminent philosopher of our day (Dr. Faraday) has said:—"There was a time when I thought I knew something about the matter, but the longer I live, and the more carefully I study the subject, the more convinced I am of my total ignorance of the nature of electricity." Such a verdict from such an eminent authority, unsatisfactory as it may be in regard to the settlement of the question, is entitled to our respect; and electricity must, for the present, remain in the same category with heat, light, and ozone, the value and properties of which we know and admit, the *nature* of which we are ignorant of. We can describe electricity as a peculiar force, obtained by peculiar means, and producing the most peculiar results; a force different in its effects from any other with which we are acquainted; but beyond this we know but little, and can only say how it is generated, and what results may be obtained by its powerful, silent, and wonderful aid.—*Dodwell's Hand Book to the Electric Telegraph.*

Railway Signal Telegraph.—A couple of years ago, a train returning from Shrewsbury to Wolverhampton, was parted into two divisions, and a portion of the foremost on arriving at the height of an inclined plane had its coupling chains broken, and dashed against the engine and carriages of the advancing train, with a violence causing death and injury to many. Something similar occurred last year at Camden Town in a returning excursion train from Kew to Blackwall. In all these cases the immediate cause of the catastrophe is traceable to the absence of rapid telegraphic and accurate communication from one station to another. When the collision in the Brighton tunnel took place, it was presumed that ill-regulated distances between trains would never appear in railway management again. But is evident that the lessons of experience are speedily forgotten in these public establishments, and the excursionist and all other trains are to take their common routine chance of danger. If this is the leading idea in the directorates, and that a too close and safe supervision will not pay, the sooner juries make our railway companies feel the result of their neglect, the better for the character of great public accommodations, and for the security of the people at large.—*Standard.*

To Correspondents.

H. A.—We shall be happy to insert a description of your very simple and, as it appears to us, promising railway signal apparatus. The subject of railway signalling is one of very great importance, as several very serious disasters have taken place upon our railways, owing to the failure or, in some cases, to the complicated character of the instruments employed.

⁂ We have received several specimens of submarine cables, designed with a view to avoid the effects of corrosion upon the iron sheathing, which we shall describe in a future number.

Teniel.—Mr. Alexander Bain made several experiments with a view of determining the point in 1841. A full description of the experiments is given in a book published by him in 1842.

K. T.—The Electric Telegraph Company was incorporated in 1846. We believe that the device on the seal of the Company was suggested by Mr. W. Fothergill Cooke.

J. P. L.—The batteries employed for experiments under the direction of the Government Telegraph Committee were supplied by Messrs. Warden and Company, in all 512 elements.

A Telegraphist.—Any information relating to the progress of telegraphy in the provinces will be most thankfully received. You will find the matter referred to in our present number.

John King.—The deposit in question is probably formed from the earthy salts contained in the water. In this case it would be prevented by using rain water in the exciting fluid. The following method is recommended for the insulating varnished paper. Lay the sheet upon a heated surface, a slab of marble or metal for example, and pass over it a piece of white wax (spermaceti) until the paper is saturated with this substance. When cold, varnish the paper on both sides with best shellac varnish, and suspend it by one corner in the open air until dry. Two or three coats of varnish are generally applied.

D. H. S.—We are anxious to forward by any means in our power the application of electrical agencies for the purpose you mention, but we cannot offer any opinion as to the relative value of the electrotype and other processes for obtaining original blocks for surface printing. The question must be left to the engravers themselves; but we are sufficiently prepossessed in favour of the electrotype process to recommend its adoption, or, at least, a trial of its merits, by those who have not become wedded to the old system.

Amelia.—Address a note to Mrs. Craig, the lady superintendent. The occupation of a female telegraphist is a most honourable one. A liberal education is a great advantage.

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The Electrician.

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CONTENTS:

	PAGE		PAGE
Electro-Magnetic Engines	217	Telegraphic Strategy	220
On the Periods Occupied in Charging Different Lengths of Telegraph Wire, &c.	217	Recent Patents	223
The Atlantic Telegraph	218	Prices Current of Insulating Materials	223
Telegraphic Transmission of Chinese Characters	218	Telegraph Shares	223
Applied Chemistry	219	Telegraphic Grievance	223
Firing Gunpowder by Electricity	219	Telegraphic News	224
International Exhibition	220	Correspondence	225
		Miscellanea	228
		To Correspondents	228

ELECTRO-MAGNETIC ENGINES.

IT was the opinion of M. GUSTAVE FROMENT, who has been particularly successful in the application of electro-motive power, that, provided the sole objection of *expense* could be removed, this agency would undoubtedly be susceptible of utilization in many mechanical operations. In reference to this practical and well-founded opinion, it will be interesting to trace how far this objection has been removed by comparatively recent discoveries and investigations in electrical science. We need scarcely advert to the many appliances for which a considerable accumulation of power is not absolutely indispensable. The distinguished mechanician, whose name we have mentioned, states, that for all delicate work, such as for giving motion to dividing instruments, polishing apparatus, &c., he has found electro-magnetic power very valuable as a mechanical agent, and constantly employs it in his workshop. We know that Captain TAYLOR and Mr. HENLEY have, by the same means, given motion to lathes capable of turning articles of wood, ivory, gun-metal, or iron; and that, with an electro-magnetic engine, Professor JACOBI, on the Neva, propelled a boat containing a number of persons, during entire days. But it is in mechanical operations where but a short "stroke," recurring with great rapidity, is required, that electro-magnetic power appears to be most applicable. It has been observed by DERMONT that "while in the development of great power, the electro-magnetic force is very inferior to that of steam, it becomes equal, and even superior to it in the production of *small* forces, which may thus be subdivided, varied, and introduced into trades and occupations using but small capitals, where the absolute amount of mechanical power is of less consequence than the facility of producing it instantaneously and at will." In this remark are condensed both the principle which should be kept in view by those who may now seek to utilize the electro-magnetic agency, and the chief advantages which will ultimately lead to its extended employment.

Besides the very general misapprehension in regard to the true field of application of this motive power, we may observe that the great facilities for the production of a current of great quantity through a circuit of small resistance has not been duly appreciated. Since the discovery of the voltaic couple of Sturgeon with cast-iron negative and single exciting fluid, it is indisputable that, for inducing magnetism in soft iron, a battery of small resistance can be worked far more advantageously and economically than one of tension. To obtain the latter property with a moderately small resistance in the battery, the consumption of the expensive reagent, nitric acid, has invariably been found necessary. We can devise no means for obviating the comparatively enormous expense which attends the general use of this very efficient oxydising medium. The zinc we consume is not, like fuel, lost; it may be recovered by means to which we shall presently advert. The collection and condensation of the nitrous vapours, to form a fresh source of nitric acid, appears impracticable in an economic point of view. On the other hand, the materials for the production of a current of low tension are comparatively inexpensive in the first instance, and, what is of far greater importance, may be utilized to obtain a fresh supply of the positive metal in the condition in which it is best adapted for use. Sulphuric acid is cheap, and there is no reason why the consumption of *pure* zinc in the battery, upon a large scale, should be objectionable on the grounds of expense. The battery residue of sulphate of zinc may readily, by means of the sulphide of barium, be made to yield the metal in the form of sulphide, and from this, zinc, in a condition of great purity, may be obtained with a small expenditure of fuel. The sulphide of barium is procured by deoxydizing the sulphate of baryta, and thus a supply of there agent may last almost indefinitely for the purpose in view. On an experimental scale, we have had some experience of the process to which we refer, which would appear to render the electro-magnetic agency one of the cheapest as well as one of the most convenient of all motive powers.

It may be objected to the use of currents under low tension, that there are difficulties in the way of obtaining a high degree of magnetic power by these means. Generally speaking, it may be easier to construct an electro-magnet of given power for a battery of tension, than for one of small resistance. In telegraph lines, for which a considerable degree of tension is necessary in working, the magnets are unavoidably constructed with a long length of fine wire. But, in electro-magnetic engines there are peculiar facilities for making the resistance of the battery circuits very inconsiderable, and the advantages in so doing, more especially on the grounds of expense, are worthy of appreciation.

In "STURGEON'S Annals" is mentioned an electro-magnet of peculiar construction, contrived by Mr. RICHARD ROBERTS, which, with a battery of 8 pairs of the zinc-iron elements, sustained the enormous weight of 2,950 lb., the magnet with its coils weighing but 35 lb. It may be interesting to refer to the mode of construction adopted in this case. The magnet appears to have been a plate of iron, about 6½ inches square, and 2½ inches thick. Into one of the faces were planed spirally four grooves, at equal distances from each other, 1¼ inches deep, and about ⅜ths of an inch broad. A stranded wire, composed of 36 No. 18 copper wires, and insulated with cotton, was coiled three-fold deep into the grooves. To the other face of the magnet was attached a ring of metal, by which the whole was suspended.

In the list of patented inventions relating to electricity, will be found descriptions of a considerable number of electro-magnetic engines, most of which are characterized by great ingenuity—though economy in battery expenditure is a point which has been in most cases disregarded. We shall be glad to hear of any novel arrangement, more especially if adapted for a particular purpose. It is more than probable that the electric silk-loom of BONELLI is but one of the first steps in a direction which will ere long be generally followed.

ON THE PERIODS OCCUPIED IN CHARGING DIFFERENT LENGTHS OF TELEGRAPH WIRE, WHEN THEIR DISTANT ENDS ARE TO EARTH.

BY RICHARD LAMING, M.R.C.S.

AUTHOR OF "STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY."

[Continued from p. 196.]

As in my last communication I failed to be convincing to the Editor of the ELECTRICIAN, I must make another attempt in the hope to do better. With respect, however, to the conclusion I had announced as the result of inductive reasoning based upon the view I take of electrical action, it will answer every needful purpose if I merely repeat that I regard the charge of telegraph cables to be resisted *within* the wires by an inertia opposed to conduction varying as the squares of their lengths, and *without* the wires by an inertia opposed to induction which is the same in amount for all lengths; for this was so fully explained last

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week, and summed up by the formula $T = L^2 + A$, that to go over it a second time cannot be necessary.

In the reproduction of the geometrical illustration from page 182, the comparison is not made of the resistances for different lengths of wire; to avoid assuming impossible conditions in the demonstrations the Editor now causes the two equal triangles, A B C and D C F, to become a possibility by *insulating* B F; he then compares them with the triangle of double length, A B F; now, as A B F can only be brought into existence by *un*insulation, he, in effect, only compares half of the charge of B F insulated, with the whole of the charge of the same B F uninsulated.

With the wire B F in its insulated condition, taking the half of its charge in the manner we are directed to do, *two* fourths of that half will have passed through B C, in order to arrive upon C F; whereas when the wire in its uninsulated state is charged with an equal quantity only *one* fourth part of it will have traversed B C in its way to C F; and as the resistances are obtained by multiplying the quantities into the mean lengths of the courses, the resistances must needs be greater in the former than in the latter case. We can therefore admit that the period of time required for charging the wire is longer under the diagonal A F, than under the two diagonals A C and D F, without rendering necessary the conclusion which has been thought inevitable.

THE ATLANTIC TELEGRAPH.

It will be recollected that some months since, at the instance of the Atlantic Telegraph Company, the Lords of the Admiralty ordered the paddlewheel steam surveying-vessel *Porcupine*, 3, to be prepared for sounding that portion of the bed of the ocean, near Ireland, on which the electric cable laid by Sir Charles Bright is supposed to have broken. Officers of experience were appointed to undertake this important duty, and an efficient crew was selected from the surveying-ship *Fisgard*, 42, at Woolwich. The *Porcupine* was supplied with ample sounding machines, including those of the *Bulldog* pattern, which bring up some of the bottom each time they are used, and with a donkey steam-engine on deck for hauling them on board. The *Porcupine* left Plymouth for the scene of her labours on the 22nd of June, arrived at Galway on the 9th of July, and departed therefrom on the 21st. She proceeded to what is termed the Cliff, about 200 miles west of Galway, and during her operations there experienced a heavy gale of wind, which carried away her rudder head. The *Porcupine* put back to Galway on the 26th of July, had her rudder repaired, and on the 6th of August sailed for Rockall-bank, some 500 miles north-west of Donegal Bay, where she arrived on the 14th, and after remaining two days, went into Killibeg's Harbour, Donegal, for fuel, and departed on the 24th for Queenstown, which was reached on the 30th. After staying till the 3rd inst., she returned to Plymouth. One of the objects of visiting the Cliff was to ascertain the exact nature of its declivity, considered to be above 1,200 fathoms in 8 miles, or a fall within that distance from a depth of 550 fathoms to a depth of 1,750 fathoms. It is stated that the officers by sounding crosswise have also discovered what the seamen call a "gap," through which a wire could be laid with less risk than where Sir Charles' wire was laid. They also discovered a steeper cliff, which they have named the Porcupine Rock. Some of the soundings extended to a depth of 2,500 fathoms. The visit of the steamer to Rockall on the 14th of August seems to have been prompted by a desire on the part of the Lords of the Admiralty to be able to judge by a knowledge of its depth and character, of the expediency of dropping a cable across this bank, for the purpose of connecting Ireland with Iceland and America. On the ridge of the bank, soundings varied from 90 to 160 fathoms; fish were most abundant; the bottom consisted of mud and sand. It is reported to be the opinion of several of the officers on board the *Porcupine*, that a line of communication which can be established without the necessity of so long a wire of that direct across the Atlantic, will be much more likely to succeed. A system of comparatively short lengths can be repaired with less difficulty in case of injury; besides which, it is believed that with the present limited extent of telegraphic science, there is no means of transmitting a message rapidly through a great length of wire. One word is said to overtake another, and it is averred that the force requisite to be exerted by the batteries for sending the fluid so great a distance, must involve injury to the wire by the necessary intensity of the electric spark. The diagrams, returns, and reports from the officers engaged on board the *Porcupine*, leave this afternoon for Whitehall for the consideration in the first place of the Lords of the Admiralty, after which communication will be made by their Lordships to the directors of the Atlantic Telegraph Company. The vessel is now at Keyham steam-yard, where she will disembark her sounding gear and machinery, and re-ship the deck-house or office, displaced for the purposes of her recent duty. She will probably leave on Wednesday for Woolwich.—*The Times*.

[Our readers will be amused by the *ex cathedra* opinion above expressed by *several officers* on board the *Porcupine*, who state "that a line of communication, which can be established without the necessity of so long a wire as that direct across the Atlantic, will be much more likely to succeed." These sapient gentlemen also opine that, with the present limited extent of telegraphic science, there is no means of transmitting a message rapidly through a great length of wire." Who can now feel surprised that doubts should exist as to the practicability of an Atlantic circuit?—Ed. E.]

TELEGRAPHIC TRANSMISSION OF CHINESE CHARACTERS.

We have already adverted to a pamphlet by Count D'Escayrac de Lauture on the "Telegraphic Transmission of the Chinese Characters," and shall now endeavour to make our readers acquainted with the system which he advocates in that *brochure*. It is to be regretted that the Count did not choose his own language as a medium for expounding so complex and intricate a subject, for although he may understand English, he does not write it sufficiently well at present for his purpose. This is merely a hint in passing, and we would not have it understood that his topic has much suffered from this want—let it be remembered only that French is better suited to such an exposition, and that most Englishmen would rather read a clear statement in that language than have to surmise what a Frenchman means when he labours to treat a difficult and abstruse subject in a foreign tongue. Count D'Escayrac de Lauture's system is somewhat similar to that of Captain Marryatt's maritime code of signals. He proposes to substitute numbers, formed of the first four numerals, for letters and words. And the chief feature of his plan is that these numbers shall refer to a tabular list of Chinese characters, which shall have its counterpart in various other languages, making it possible for persons of different languages to communicate with, and receive messages from, Chinese. The mode of arranging these characters is ingenious and simple. They are to be laid out in squares. Take one square and divide it into four smaller squares; then the square in each angle of the large one shall be represented by a figure thus,

1	2
3	4

If we lay out a large square, and thus divide it, and again subdivide each small square into four, and each of these again into four squares, and these again likewise, and once again, we shall have respectively 4, 16, 64, 256, 1,024, and by another similar subdivision 4,096 places. These might contain 4,096 Chinese characters or English words, and each of these would have a special number for its signal to be produced in the manner following. The largest square would have four quarters. Let *x* be a certain character in the quarter No. 2 of them; but this quarter would have four quarters; then let *x* be in quarter No. 3 of them. But No. 3 would have four quarters, then let *x h* in quarter No. 1 of them; but this again would have four quarters, and let *x h* in No. 2 of them; and No. 2 would have four quarters; then let *x* be No. 4 of them. The signal for *x* would be 23,124. Count D'Escayrac de Lauture would employ only four signals to produce this result, and the numbers would be read off immediately by the clerk from the printed tabular list in Chinese or in any European tongue. It is a fact that less than 2,000 characters come into ordinary use in Chinese, and with these a vast number of ideas may be conveyed, as they are the elements of many thousands of words, as well as being words themselves. The Count's system is, in our opinion, far superior to any for China which has been heretofore suggested, and it principally arises from this simple mode of placing the Chinese characters so that the signal-number may be at once known, and the place of a word at once found from that number. For a European to communicate with a Chinese, he would require a vocabulary of his own language, to each word of which the signal-number would have to be attached, and before sending a messenger these words would have to be found. This might be extended so as to form a telegraphic dictionary, which would enable a Frenchman or a Russian to communicate with a Chinese without understanding a word of his language. The system would seem to propose that a certain number of common characters and radical words in Chinese should become the basis of telegraphic communication, that these printed in squares (as above explained) should have counterparts in other languages, and that these languages should each possess a vocabulary of words with the signal-numbers attached, prefaced by a short exposition of the simple system of Chinese grammar, which would thus become the grammar of telegraphy, and so render it possible for any Europeans who

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possessed the counterpart of the Chinese table in their own language, and the vocabulary of signal-numbers, to communicate, not only with Chinese, but also with any other Europeans who had a similar table and vocabulary in their language. It certainly does seem to us that this system offers great advantages, and aims at a further development of the wondrous power of the electric telegraph. There was a time when a learned scholar thought Chinese was to be the universal language, and that its ideographic characters would make themselves understood throughout the world, if they could only be introduced; but that theory very properly died a natural death. There seems, however, to be no reason why the simple and philosophic system of Chinese writing and grammar should not be adopted, if (as we think) it can be shown to be simpler than any other, while its characters define more clearly than any alphabetic language can, the ideas which they convey. In telegraphing alphabetic languages word by word is spelt out. When the word is transmitted, the slightest error may confound, and the word is a mere sound; but the Chinese characters do not convey sounds, they represent ideas, and when, by a number, a certain character is indicated, all is clear. The language, again, is so terse, or may be so employed, that less than one-half the number of signals would suffice to convey a sentence which would be required in transmitting European tongues.

The advantages, in a commercial and political point of view, which the electric telegraph would serve at present in China, cannot be over-rated, and we hope that British capitalists or the Chinese Government may be induced to engage in starting it in that country.—*The London and China Telegraph.*

APPLIED CHEMISTRY.

SILVERING GLASS AND OTHER SURFACES.

THE process embodied in the following specification of the patent, dated March 13, 1861, of Mr. John Cimeg, "for improvements in silvering glass and other surfaces," may occasionally be found applicable for the purpose of giving a conducting surface to articles which it is intended to cover with an electro deposit of metal, and to which plumbago will not readily adhere. This invention has, for its object, improvements in silvering glass and other surfaces. For this purpose I employ a mixture of ammonia, nitrate of silver, with a solution of Rochelle salt (tartrate of potash and soda); this mixture is applied to the surface of glass to be silvered, and after a short time the silver is deposited on the glass as a bright film. The silver is deposited at the ordinary temperature of the air; thus it is not necessary to heat the surface, as when other mixtures are employed. The film of silver may be strengthened by depositing over it a cheaper metal, such as copper. The process above described is also applicable for silvering other surfaces; it is, for example, very useful for giving a metallic and conducting surface to articles on to which it is desired to deposit copper by electricity, and where the article itself is not a conductor of electricity.

In order to silver the surface of the paper, or of a woven fabric, or other similar surface, I first deposit the silver on to a polished surface, such as glass; then attach the fabric thereto by suitable cement, and carefully strip the fabric, together with the silver, from the polished surface. In some cases, I obtain an ornamental effect by depositing the silver on a surface on which a pattern has been produced by dulling a portion of the surface.

And in order that my said invention may be most fully understood and readily carried into effect, I will proceed to describe minutely the manner in which I prefer, in practice, to conduct the processes.

In order to silver a sheet of glass, I place the said sheet, previously washed clean with water, on a table, and rub the whole surface of the sheet with a rubber of cotton, or other soft fabric, wetted with distilled water, and afterwards with a weak solution of Rochelle salt in distilled water, about one part of salt in 200 parts of water. I then take a solution, previously prepared by adding nitrate of silver to ammonia of commerce; the nitrate of silver being very gradually added until a brown precipitate commences to be produced, and the solution is then filtered.

For each square yard of glass to be silvered, I take as much of the above solution as contains 20 grammes (about 309 grains) of nitrate of silver, and to this I add as much of a solution of Rochelle salt, in distilled water, as contains 14 grammes of salt, and the strength of this latter solution should be so adjusted to that of the silver solution that the total weight of the mixture of the two, in the quantities above mentioned, may be 60 grammes. In a minute or two after the mixture is made it begins to become turbid, and it is then immediately to be poured over the surface of the glass, which has previously been placed on a perfectly horizontal table, but the plate is blocked up at one end, so as to give it an inclination of about one in forty; the liquid is poured on to the plate, along the higher edge, and it runs towards the lower; the pouring is done in such a manner as to distribute the liquid over the whole surface of the plate, without allowing any to escape at the edges. When this is effected, the plate is placed in an horizontal position, at a temperature of about 68° F. The silver will begin to appear in about two minutes. Before the end of ten minutes the plate will be covered, and in thirty minutes sufficient silver will be deposited; this is about two grammes of silver per square yard, which is enough for most purposes. The mixture is then poured off the plate, and the silver it contains is afterwards recovered. The silvered surface of the glass is then washed by pouring water over it four or five times, and the plate is set up to drain and dry. When dry, the silvered surface is varnished by pouring over it (in the same way as the mixture is poured on, as already described) a varnish, composed of the following materials, viz.:—Gum dammar, 20 parts; asphalte (bitumen of Judea), 5 parts; gutta percha, 5 parts; benzine, 75 parts. This varnish dries and sets hard on the surface, and the glass is then ready for framing, or otherwise for use as may be required. When a surface of glass has been silvered, as above described, a layer of copper may be deposited over the silver by the ordinary electrotype process or otherwise, as is well understood. I do not, however, prefer to do this when the object is to obtain a silvered glass, but in some cases I deposit a considerable thickness of copper on to the silver, and then strip the copper and silver together from the glass, which will be done with facility when the coating of copper is thick. In this manner a sheet of any size of plated copper may be produced, plates of other non-absorbent materials (which will not act chemically on the silver solution) may be coated with silver in the same manner as plates of glass. When it is desired to give a metallic and conducting surface to an article which it is desired to electrotype, say, for example, a medallion of wax or gutta percha, I silver it as already described, sufficient of the silvering mixture being employed to cover every part of the surface. In order to silver paper, woven fabrics, and other materials according to my invention, I, as already mentioned, strip the silver from the surface on which it is deposited by attaching to it the paper, woven fabric, or other similar material, and then removing the said material and the silver film together from the surface. The silver is first deposited, by preference, as already described, but it may be otherwise, on to a surface, by preference of glass, then on to the silvered surface is poured in the manner already set out, a varnish consisting of gum lac dissolved in wood spirit, one part of gum lac to from six to ten of wood spirit. When this varnish is dry and hard, a solution of one part of gelatine in from six to ten of water is also poured over, and allowed to set into a jelly; the paper, leather, or woven fabric, or other similar material to be silvered, is laid on and pressed in contact with the jelly, and it is then left to dry thoroughly; afterwards the material with the fabric is stripped from the surface, and the process is complete.

FIRING GUNPOWDER BY ELECTRICITY.

AN important report has been presented to the Secretary of State for war on the results of elaborate investigations and experiments made at Woolwich and Chatham by a Committee on the Application of Electricity from different sources to the explosion of gunpowder. The report is drawn up by Professor Wheatstone and Mr. Abel, Chemist to the War Department. The following are the conclusions arrived at:—

1st. The explosion of a single charge of powder by means of the phosphide of copper fuze and a magneto-electric apparatus (even of the smallest size generally manufactured) is absolutely certain.

2nd. The phosphide of copper fuze is as safe and permanent as any arrangement employed in the service for the ignition of gunpowder by the aid of friction or percussion.

3rd. With the employment of a magneto-electric apparatus similar to that used in the Chatham experiments, and termed by Mr. Wheatstone, the "Magnetic Exploder," the ignition at one time of fuzes, varying in number from 2 to 25, is certain, provided these fuzes are arranged in the branches of a divided circuit in the manner described. To attain this result it is only necessary to employ a single wire, insulated by a coating of gutta percha or india rubber, and simple metallic connections of the apparatus and the charge with the earth.

4th. The explosion of from 12 to 25 charges may be effected in the above manner, at a distance of at least 600 yards from the apparatus, with a rapidity which, in its results, will, in all probability, have the practical effect of a simultaneous discharge. This statement, however, only refers to charges on land.

5th. The number of submarine charges which can be exploded with certainty at one time, by means of the magnetic exploder, is more limited; but if such charges are entirely or partially embedded in sand, mud, or other dense materials, from two to ten may be fired with certainty. If the charges are suspended in, or are immediately in contact with water, only four can be exploded at one time with certainty. By the employment of separate wires leading from the instrument to each charge, there is little doubt, however, that the results obtained with the magnetic exploder in submarine operations would be quite equal to those definitely established for the ignition of charges on land.

6th. The only important precautions to which it is necessary to attend rigidly in order to ensure uniform success in the application of the magnet are the proper insulation, throughout, of the main wire and branch wires leading from the instrument to the charges, and the thorough protection of all connections of wires from the access of moisture.

7th. The system of firing charges by magneto-electricity thus possesses important advantages over the application of the voltaic battery to this

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purpose, the principal of which are, the small dimensions, weight, and cost of the magnetic exploder; that used in the experiments alluded to in the report weighed only 32 lb. 11 oz., and all the arrangements in connection with the instrument are so simple, that any injury which they may sustain can be repaired by ordinary workmen.

Electricity was applied to the explosion of gunpowder by Franklin in 1751, and by Priestly in 1767; but it was not till after the discovery of the voltaic pile that earnest endeavours were made to apply electricity to mining and military purposes. In 1832 French military engineers experimented on it. About twelve years afterwards, electricity was employed in important blasting operations—such as the destruction of Round Down Cliff, near Dover, and the breaking up of the wreck of the *Royal George*, at Spithead. The valuable discoveries of Faraday in electro-magnetism and magneto-electricity of late years have gradually led to experiments on the possible application of electro-magnetic induction apparatus for military purposes.

International Exhibition.

ELECTRIC ENGRAVING MACHINE.

WE strongly advise those of our readers who feel interested in the extension of the application of electricity to the purposes of art, to examine a very simple and efficient machine, exhibited in class VII at the International building. This machine is used for engraving the cylinders of copper or brass, employed in the printing of woven fabrics and paper hangings.

To those who have visited any of the large printing works of the north, the importance of the invention is apparent.

The great distinctive feature in the machine, apart from its general mechanical arrangement, is in the application of the subtle agency of voltaic electricity in communicating certain necessary movements to important and delicate portions of the apparatus.

The cylinder to be engraved is first coated on its outer surface with a thin film of varnish, sufficiently resistant to the continuous action of the strongest acids. The requisite number of copies of the original design are then traced or scratched *simultaneously* by a series of diamond points, which are arranged on the machine, parallel with the axis of the cylinder. The metallic surface is thereby exposed in certain parts, and a bath of nitric or other acid being afterwards used to etch or deepen the engraved portion, the operation is completed.

Each diamond point is in correspondence with a small temporary magnet, and the entire series is so arranged *en rapport* with the original design that intermittent currents are established, whereby the diamonds are withdrawn from their work at the proper intervals.

Amongst other special advantages to be derived from the use of this apparatus, the facility with which engravings may be enlarged or diminished to any necessary extent from the same original, is not the least important, its capability of producing variety of results has very wide limits.

TELEGRAPHIC STATEGY.—A CURIOUS CHAPTER IN THE HISTORY OF THE AMERICAN WAR.

THE following account, from the *Augusta Southern Confederacy*, of a novel mode of employing telegraphic agency in warfare, may afford both amusement and instruction to some of our readers:—

Intercepted Dispatches, taken by G. A. Ellsworth, Telegraphic Operator attached to Colonel Morgan's Band of Confederates.

Knoxville, July, 30.

Captain R. A. Alston, A.A.G. — On the 10th of July General Morgan, with myself and a body guard of 15 men, arrived a point half a mile below Horse Cave, on the Louisville and Nashville Railroad, where I took down the telegraph wire and connected my pocket instrument, for the purpose of taking off all dispatches as they passed through. Owing to a heavy storm prevailing south the atmospheric electricity prevented me from communicating with Bowling Green or Nashville. The first I heard was Louisville calling Bowling Green. I immediately put on my ground wire southward, noticing particularly at the same time what change it would make in the circuit. It did make it stronger; but the storm mentioned affecting telegraphs more or less, Louisville did not suspicion anything wrong, and I answered for Bowling Green, when I received the following message:—

"*Louisville, July* 10, 1862.

"TO S. D. BROWN, BOWLING GREEN.

"You and Colonel Houghton move together. I fear the force of Colonel H. is too small to venture to Glasgow. The whole force should move together, as the enemy are mounted. We cannot venture to leave the road too far, as they may pass round and ruin it.

"J. T. BOYLE,
"Brigadier General commanding."

I returned the usual signal, "O. K.," after receiving the message.

Louisville immediately called Nashville; and I answered for Nashville, receiving business for two hours. This business was mostly of a private nature, and I took no copies. It could be plainly perceived from the tenor of the messages that Morgan was in the country, and all orders to send money or valuables by railroad were countermanded as they supposed. Little did the operator at Louisville think all his work would have to be repeated the next day. Louisville also sent the news of the day, and thus we were furnished with New York and Washington dates of that day. During the whole of this time it was raining heavily, and my situation was anything but an agreeable one—sitting in the mud with my feet in the water up to my knees. At eleven o'clock p.m., the general being satisfied that we had drained Louisville of news, concluded to close for the night, and gave me the following message, dating and signing:—

"*Nashville, July* 10, 1862.

"TO HENRY DENT, PROVOST MARSHAL OF LOUISVILLE.

"General Forrest, commanding a brigade, attacked Murfresboro,* routing our forces, and is now moving on Nashville. Morgan is reported to be between Scottsville and Gallatin, and will act in concert with Forrest, it is believed.

"Inform the general commanding.

"STANLEY MATTHEWS, Provost Marshal."

I am not aware that General Morgan claims to be a prophet, or the son of a prophet; but Forrest did attack Murfressboro, and rout the enemy.

On arriving at Lebanon, July 12, I accompanied the advance guard into the town, and took possession of the telegraph office immediately. This, as you know, was at half-past three a.m. I adjusted the instrument and examined the circuit. No other operator on the line appeared to be on hand thus early. I then examined all the dispatches of the day previous. Among them I found the following:—

"*Lebanon, July* 11, 1862.

"General J. T. Boyle, Louisville, Ky.:—

"I have positive information that there are 400 marauders in the twenty miles of this place, on the old Lexington Road, approaching Lebanon. Send reinforcements immediately.

"A. Y. JOHNSON, Lieut.-Colonel Commanding."

At half-past seven an operator signing himself "Z" commenced calling "B," which I had ascertained by the books in the office was the signal for the Lebanon office. I answered the call, when the following conversation between "Z" and myself ensued:—

"To Lebanon.—What news? Any more skirmishing after your last message? "Z."

"To Z.—No. We drove what little cavalry there way away. "B."

"To B.—Has the train arrived yet? "Z."

"To Z.—No. About how many troops on train? "B."

"To B.—Five hundred Sixtieth Indiana, commanded by Colonel Owens. "Z."

My curiosity being excited as to what station "Z" was, and to ascertain without creating any suspicion, I adopted the following plan:—

"To Z.—A gentleman here in the office bets me the segars you cannot spell the name of your station correctly. "B."

"To B.—Take the bet. L-e-b-a-n-o-n J-u-n-c-t-i-o-n. Is this not right? How did you think I would spell it? "Z."

"To Z.—He gives it up. He thought you would put two b's to Lebanon. "B."

"To B.—Ha! ha! ha! He is a green one. "Z."

"To Z.—Yes; that's so. "B."

"To Z.—What time did the train with soldiers pass, Z? "B."

"To B.—8·30 last night. "Z."

"To Z.—Very singular where the train is. "B."

"To B.—Yes, it is. Let me know when it arrives. "Z."

At 8·20 Lebanon Junction called me up and said:—

"To B.—The train has returned. They had a fight with the

* [The taking of Murfreesboro by Forrest was three days afterwards—on the 13th.—EDS. CONFED.]

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rebels at New Hope. The commanding officer awaits orders here. "Z."

"To Z.—Give us the particulars of the fight. Colonel Johnson is anxious to know all about it. "B."

"To B.—Here is Moore's message to General Boyle:—

"*Lebanon Junction, July* 12, 1862.

"TO GENERAL J. T. BOYLE, LOUISVILLE.

"At eleven o'clock last night, at New Hope station, part of my command encountered a force of rebel cavalry, posted on the country road, one half mile south of the railroad. After a brisk fire of musketry for twenty minutes, the enemy was routed and fled. Skirmishers were sent out in different directions, but were unable to find the enemy. At three this morning, apprehending that an effort might be made to destroy the bridges in our rear, we moved down to New Haven, and remained until after daylight, when the train went back to the scene of the skirmish. A Mr. Foreman, of Owen County, was found mortally wounded. He reported the rebel force at 550, under command of Captain Jack Allen, and that they had fallen back towards Greensburg. One horse was killed and three captured. The books of the company were found in the field. Blood was found in different places, showing that the enemy was severely punished. No casualties on our side. Here with a train awaiting orders.

"O. F. Moore, Commanding."

Lebanon Junction being the repeating station for Louisville business, he forwarded the following tellegrams just from Louisville—nine o'clock, a.m.:—

"*Louisville, July* 12, 1862.

"TO COLONEL JOHNSON, LEBANON.

"Leave good guard and join Colonel Owens. Pursue the enemy and drive him out. Be cautious and vigorous. Make no delay.

"J. T. Boyle, Brigadier-General Commanding."

By the following it will appear that Colonel Owens must have been *en route* for Lebanon:—

"*Louisville, July* 2, 1862.

"TO COLONEL OWENS, LEBANON.

"You will move after the enemy and pursue him.

"J. T. Boyle, Brigadier-General Commanding."

Up to the time of our leaving Lebanon, which was about noon, Colonel Owens had not arrived. General Morgan told me I could close my office; and to allay for that evening all suspicion at Lebanon Junction at not being able to communicate with Lebanon, I despatched the operator as follows:—

"To Z.—Have been up all night and am very sleepy. If you have no objections I will take a nap until two or three o'clock. "B."

"To B.—All right. Don't oversleep yourself. "Z."

Wonder if I did.

We arrived at Midway, between Frankfort and Lexington, on the Louisville and Lexington Railroad, about ten o'clock a.m., the next day. At this place I surprised the operator, who was quietly sitting on the platform at the depôt, enjoying himself hugely. Little did he expect that the much dreaded Morgan was in his vicinity. I demanded of him to call Lexington and inquire the time of day, which he did. This I did for the purpose of getting his style of handling the "key" in writing despatches. My first impressions of his style, from noticing the paper in the instrument, were confirmed. He was, to use a telegraphic term, a "plug" operator. I adopted his style of writing and commenced operations. In this office I found a signal book, which proved to be very useful. It contained the calls for all the offices. Despatch after despatch was going to and from Lexington, Georgetown, Paris, and Frankfort, all containing something in reference to Morgan.

On commencing operations at this place, I discovered that there were two wires on the line along this railroad. One was what we term a "through wire," running direct from Lexington to Frankfort, and not entering any of the way offices. I found that all military messages were sent over that wire. As it did not enter Midway office I ordered it to be cut, thus forcing Lexington on to the wire that did run through the office.

I tested the line, and found that by applying my ground wire, it made no difference with the circuit; and as Lexington was headquarters, I cut Frankfort off. Midway was called. I asked and received the following:—

"*Lexington, July* 15, 1862.

"TO J. W. WOOLUMS, OPERATOR, MIDWAY.

"Will there be any danger in coming to Midway? Is everything right? "Taylor, Conductor."

I enquired of my prisoner (the operator), if he knew a man of the name of Taylor. He said that Taylor was conductor. I immediately gave Taylor the following reply:—

"*Midway, July* 15, 1862.

"TO TAYLOR, LEXINGTON.

"All right; come on. No signs of any rebels here.

"Woolums."

The operator in Cincinnati then called Frankfort. I answered, and received about a dozen unimportant despatches. He had no sooner finished when Lexington called Frankfort. Again I answered, and received the following message:—

"*Lexington, July* 15, 1862.

"TO GENERAL FINNELL, FRANKFORT.

"I wish you to remove the force at Frankfort on the line of the Lexington railway immediately, and have the cars follow and take them up as soon as possible. Further orders will await them at Midway. I will, in three or four hours, move forward on the Georgetown pike; will have most of my men mounted. Morgan left Versailles this morning, at eight o'clock, with 850 men on the Midway Road, moving in the direction of Georgetown.

"Brigadier-General Ward."

This being our position and intention exactly, it was thought proper to throw General Ward on some other track. So, in the course of half an hour, I manufactured and sent the following despatch, which was approved by General Morgan:—

"*Midway, July* 15, 1862.

"TO BRIGADIER-GENERAL WARD, LEXINGTON.

"Morgan, with upwards of one thousand men, came within a mile of here, and took the old Frankfort Road, bound, as we suppose, for Frankfort. This is reliable.

"Woolums, Operator."

In about ten minutes Lexington again called Frankfort, when I received the following:—

"*Lexington, July* 15, 1862.

"TO GENERAL FINNELL, FRANKFORT.

"Morgan, with more than one thousand men, came within a mile of here, and took the old Frankfort Road.

"This despatch, received from Midway, and is reliable. The regiment from Frankfort had better be recalled.

"General Ward."

I receipted for this message, and again manufactured a message to confirm the information General Ward had received from Midway, and not knowing the tariff from Frankfort to Lexington, I could not send a formal message, so, appearing greatly agitated, I waited until the circuit was occupied, and broke in, telling them to wait a minute, and commenced calling Lexington. He answered with as much gusto as I called him. I telegraphed as follows:—

"Frankford to Lexington.—Tell General Ward our pickets are just driven in. Great excitement. Pickets say the force of enemy must be 2,000.

"Operator."

It was now two o'clock p.m., and Genegral Morgan wished to be off for Georgetown. I run a secret ground connection, and opened the circuit on the Lexington end. This was to leave the impression that the Frankfort operator was skedaddling, or that Morgan's men had destroyed the telegraph.

We arrived at Georgetown at about the setting of the sun. I went to the telegraph office, found it locked, and inquired for the operator, who was pointed out to me on the street. I hailed him, and demanded admission into his office. He very courteously showed me in. Discovering that his instruments had been removed, I asked where they were? He said he had sent them to Lexington. I asked him what time he had Lexington last. He said, "Nine o'clock, and since that time the line had been down." I remarked, that it must be an extraordinary line to be in working condition when it was down, as I heard him sending messages to Lexington when I was at Midway at one o'clock. This was a stunner; he had nothing to say. I immediately tested the line by applying the ends of the wires to my tongue, and found the line "O. K." I said nothing to him, but called for a guard of two men to take care of Mr. Smith, until I got ready to leave town. I did not interrupt the line till after tea, when I put in my own instruments, and after listening an hour or two to the Yankees talking,

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I opened the conversation as follows, singing myself "Federal Operator":—

"To Lexington.—Keep mum. I am in the office, reading by the sound of my magnet, in the dark. I crawled in when no one saw me. Morgan's men are here, camped on Dr. Gano's place.
"Georgetown."

"To Georgetown.—Keep cool; don't be discovered. About how many rebels are there?
"Lexington."

"To Lexington.—I don't know; I did not notice. As Morgan's operator was asking me about my instruments; I told him I sent them to Lexington. He said, 'D—n the luck,' and went out.
"Georgetown."

"To Georgetown,—Be on hand, and keep us posted.
"Lexington."

"To Lexington.—I will do so. Tell General Ward I'll stay up all night, if he wishes.
"Georgetown."

"To Georgetown.—Mr. Fuller wishes to know if the rebels are there.
"Cincinnati."

"To Cincinnati.—Yes; Morgan's men are here.
"Georgetown."

"To Georgetown.—How can you be in the office and not be arrested?
"Cincinnati."

"To Cincinnati.—Oh, I am in the dark, and am reading by the sound of the magnet.
"Georgetown."

This settled Cincinnati. Question after question was asked me about the rebels, and I answered to suit myself.

Things had been going on this way about two hours, when Lexington asked me where my assistant was? I replied, "Don't know." He then asked me, "Have you seen him to day?" I replied, "No." This was the last telegraphing I could do in Georgetown.

I then called on Mr. Smith, the operator, who was under guard in my room, and informed him that I would furnish him with a mule in the morning, and should be pleased to have him accompany me to Dixie, as I understood he was in the employ of the United States Government. This was anything but agreeable to him. I thought I had struck the young man in the right place, and remarked that, had he not sent his instruments to Lexington, I should have taken them in preference to his person. His face brightened, and an idea struck him very forcibly, from which he made a proposition. It was to furnish me the instruments if I would release him.

This I agreed to, as such his instruments were of much more value to the Confederacy than Yankee telegraphers. I accompanied him to the servant's room, and there, under the bed, in a chest, we found the instruments. Mr. Smith, having given me his word on honour, that he would not leave town for the next twenty-four hours, he was set at liberty to visit his wife and the young Smiths.

On arriving at Cynthiana, I found that the operator had skedaddled. I tested the wires and found no fluid from either Covington or Lexington, nor were the wires in working order when I left the office next day.

At Paris the operator had made a clean sweep. He left the night before, taking all his instruments.

At Crab Orchard there was no office, and I had to put in my pocket magnet, which I did at eleven a.m. The first message I received was the following:—

"*Louisville, July* 21, 1862.

"To Colonel Woolford, Danville.

"Pursue Morgan. He is at Crab Orchard, going to Somerset.
"Boyle."

No sooner had the Danville operator receipted for this than the operator at Lebanon suggested the following:—

"To Lebanon Junction.—Would it not be well for Danville and offices below here to put on their ground wires when they send or receive important messages, as George Ellsworth, the rebel operator, may be on the line between here and Cumberland Gap?
"Lebanon."

The operator at the junction agreed with him, and said it would be a good idea, but it was not carried into effect.

We arrived at Somerset that evening. I took charge of the office. I ascertained from citizens that it had been closed three weeks, up to the very hour that our advance guard arrived in town. It was just opened by the operator from London, who came to work the instrument for the purpose of catching Morgan; but, fortunately for Uncle Sam, the operator, and all concerned, he had no time to either send or receive a message; but he had it in fine working condition for me. I had been in the office for some time when Stanford called Somerset and said:—

"I have just returned from Crab Orchard, where I have been to fix the line. The rebels tore it down. I left there at eight o'clock. The 9th Pennsylvania Cavalry had not then arrived. What time did you get in from London? "Stanford."

"To Standford—Just arrived and got my office working finely.
"Somerset."

"To Somerset—Any signs of Morgan yet; he left Crab Orchard at 11·30 to-day. "Stanford."

"To Stanford—No signs of him as yet. "Somerset."

"To Somerset—For fear they may take you by surprise, I would suggest we have a private signal. What say you? "Stanford."

"To Stanford—Good. Before signing, we will make the figure 7.
"Somerset."

This was mutually agreed upon.

I asked when Woolford would be at Somerset. He said Woolford had telegraphed Boyle that his force was green and insufficient to attack Morgan.

Seeing there was no use of my losing a night's rest, I told Stanford I would retire, that I had made arrangements with the pickets to wake me up in case Morgan came in. The operator at Lebanon Junction urged me to sit up, but I declined, on the ground of being unwell. This did not satisfy him, but after arguing with him for some time, I retired.

July 22.—Opened the office at seven o'clock a.m.; informed the Stanford operator that Morgan had not yet arrived: made inquiries about different things; and, after everything in the town belonging to the United States was destroyed, the general gave me a few messages to send—one to Prentice, one to General Boyle, and one to Dunlap. They are hereto annexed.

I then telegraphed home, informing my relatives of my whereabouts, what I was doing, &c. I then transmitted the general's dispatches, as follows:—

"*Somerset, July* 22, 1862.

"George D. Prentice, Louisville.

"Good morning, George D. I am quietly watching the complete destruction of all of Uncle Sam's property in this little burgh. I regret exceedingly that this is the last that comes under my supervision on this route. I except in a short time to pay you a visit, and wish to know if you will be at home. All well in Dixie.
"John H. Morgan, Commanding Brigade."

"General J. T. Boyle, Louisville.

"Good morning, Jerry. This telegraph is a great institution. You should destroy it, as it keeps you too well posted. My friend, Ellsworth, has all of your despatches since the 10th of July, on file. Do you wish copies? "John H. Morgan, Commanding Brigade."

"Hon. George W. Dunlap, Washington City.

"Just completed my tour through Kentucky—captured seventeen cities, destroyed millions of dollars' worth of United States property; passed through your county, but regret not seeing you. We paroled 1500 rebel prisoners, "Your old friend,
"John H. Morgan, Commanding Brigade."

[The foregoing despatches were well calculated to dumbfound these Yankee dignitaries, who no doubt were half inclined to pronounce them some spiritual freak; but for concentrated audacity the following is unequalled.—Eds. Confed.]:

"General Order.—No. 1.

"*Head-quarters, Telegraph Department of Kentucky, Confederate*
"*States of America, Georgetown, Kentucky, July* 16, 1862.

"When an operator is positively informed that the enemy is marching on his station, he will immediately proceed to destroy the telegraph instruments and all material in his charge. Such instances of carelessness as were exhibited on the part of the operators at Lebanon, Midway, and Georgetown, will be severely dealt with.

"By order of
"G. A. Ellsworth, General Military Superintendent,
"C. S. Telegraph Department."

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Recent Patents.

161. M. HENRY, Fleet street, London. "*Applying electricity to horology.*" A communication.—Dated 21st January, 1862.

THE patentee claims, first, the mode of regulating clocks by electricity, according to which one clock is regulated, or a number of clocks is consecutively regulated, by so arranging and combining the clocks that they shall always gain or be too fast till the period for regulating them has come round; that when that period has come round they shall stop for a short interval to await the regulating current, which will allow them to go on again at the exact time, and that the stopping intervals of all the clocks to be regulated shall be respectively so arranged that thirty clocks, or as many as a single current can regulate at a time, shall have their stopping intervals at the same time, so as to be all actuated by the same current, as described. Secondly, the application to, or the employment in, clocks of the arrangement and combination of contact or stopping apparatus described, constituting the mode of modifying clocks to adapt them for the method of regulation described. Thirdly, the mode of regulating clocks by secondary regulating clocks or subordinate standard clocks, which are regulated as described, and which themselves regulate subordinate groups of clocks by consecutive currents acting on the respective groups duly regulated to receive them, substantially as described. Fourthly, the improved mode of transmitting electric currents described for the purpose of regulating clocks by electricity.

188. T. MORRIS, and R. WEARE, Birmingham, and E. H. C. MONCKTON, Fineshade, Northampton, "*Submarine and other Telegraphic Communication.*" Dated 24th January, 1862.

THIS invention consists in the application of electric light, however generated, to the purpose of producing signals and communicating intelligence. The apparatus consists of one or more vacuum tubes or vessels of glass or other suitable material, or combination of materials, variously shaped and coloured, or not, and prepared by a special process.

194. C. WEST, Derby street Westminster, "*Improvements in the insulation and covering of wire, and in the preparation of the materials for insulating the same.*"—Dated 25th January, 1862.

IN carrying out this invention the patentee uses only the very best South American rubber, not masticated, but in its native state. He prepares the rubber by boiling it in water, with or without any other mixture, or by steaming it after it has been cut into ribbons or strips from the bottle or block, after boiling or steaming it. He then allows the moisture to evaporate until the rubber is perfectly dry, and in this state he stores it until required for use. Previously, however, to placing the rubber on the wire he steeps it in warm water, according to the present usual practice. The rubber so prepared will then be open to the action of the solution, he purposed applying to it while placing it round the wire, which solution will consists of india rubber dissolved in benzine, or any of the other solvents of india rubber; or it will consist of the solvents themselves, either in combination or singly. He places a trough over the wire, through which he allows the solution to percolate on the wire or on the rubber just as it enters the mandril, with a receiving dish underneath to catch such of the solution as may fall from the passing wire. After passing through the mandril the wire or rubber that is thus saturated with the solution receives the rubber to be wound upon it from the reel or bobbin as it revolves round it, and the tension at which the rubber is placed round the wire, at each revolution of the reel or bobbin, presses the solution through the interstices of the overlapping, and thus unites it into one solid tube.

236. J. B. HARRY, Leytonstone, Essex, "*Preserving electric telegraph cables and wires.*" Dated 29th January, 1862.

THIS invention consists in impregnating or coating the yarn or textile fabric or fibres employed in the manufacture of electric telegraph cables with a composition of solution of caoutchouc, resin, and powdered chalk, the proportions of the materials being varied according to the pliability required when the composition is set. In some cases the patentee mixes with the composition arsenic or other poison to guard against the attack of fish, insects, and animals. The invention also consists in coating the conducting wires, whether in submarine, subterranean, or suspended telegraphs, as also complete cables and the separate wires composing the cable, with the said composition, which he applies in a heated state. The suitable proportions of the materials forming the composition are as follows:—Caoutchouc, 1 part; resin, 3½ parts; chalk, 3½ parts; arsenic, 1-16th part.

413. J. CHATTERTON, *Highbury, Middlesex, and* W. SMITH, *Dalston, Middlesex,* "*Telegraph cables.*"—*Dated* 15*th February*, 1862.

The object of this invention is to render submarine cables incorrodible, and it consists, first, in coating or covering each iron or steel wire or strand of wires or strips, which are to be used for the external protection of the core or insulated conductor of the cable with lead or other soft metal incorrodible in sea water. Secondly, the invention consists in coating strands of wires, by preference strands composed of three wires of iron or steel, with a suitable compound and gutta percha. The "serving" generally used, may be dispensed with, the gutta percha covering acting as a cushion between the core and metal protecting wires.

359. R. JOHNSON, *Manchester*, "*Welded wires used for telegraphic and other purposes.*"—*Dated* 11*th February*, 1862.

This invention has for its object the strengthening of those joints which are produced by welding, and the maintenance of a continuity should the welding give way. These advantages the patentee proposes to attain by protecting the said joints with a metal covering, and this he forms by winding wire or other such material around the joint, so that, should the welding break, the said wire will still constitute a connection or conducting medium. By a subsequent process of galvanizing the whole becomes soldered together.

340. J. DICKSON, *Holloway*, "*Voltaic apparatus.*"—*Dated* 10*th February*, 1862.

The discovery upon which this invention is based is that, by raising the temperature of the electrotypes and substances employed in the evolution of voltaic electricity, the facility of evolving such electricity from the substances now usually employed for that purpose is increased, and further, that the increase of the electric fluid obtained by this method, is such as to render certain cheap and easily procurable materials (from which the electric fluid has not, by any means hitherto known, been obtained in quantities sufficient to warrant their employment in manufacture) remuneratively available for the purpose of such manufactures. The substances employed are iron, zinc, lead, and carbon.

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

Para	1s. 11d. to 2s. per lb.
Negro Head	1s. 1d. to 1s. 3d. „
Java	1s. 4d. to 1s. 5d. „

Very quiet market.

GUTTA PERCHA.

Fine	2s. 4d. to 2s. 6d. per lb.
Genuine Mixed	1s. 6d. to 1s. 9d. „
Ordinary Reboiled	10d. „

Rather more enquiry for fine genuine.

September 11, 1862. WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic, A.	100	50 to 54 x.d.	——
20	Do. B 7 per cent. till 1862 .	all	19 to 21	——
20	Do. C	all	——	——
Stock	Electric Telegraph . .	100	99 to 102	101 a 2
25	Do. New	20	——	——
5	London District Telegraph .	4¾	4¼ to 3¾ dis.	——
10	Lond. & S. Ireld. Direct Tel.	2	—— pm.	——
10	Mediterranean Extension Tel.	all	3½ to 4½	——
10	Do. 3 per cent. pref. . .	all	——	——
1	Submarine Telegraph, scrip.	all	⅜ to ⅝ x.d.	——
1	Do. registered . . .	all	⅜ to ⅝	——
10	Do. „ . . .	all	4 to 5	——
2	Telegraph to India . .	1	⅝ to ⅜ dis.	——
5	United Kingdom Telegraph .	8	½ dis. to par.	——

TELEGRAPHIC GRIEVANCE.

SEVERAL communications, out of which we have selected one for insertion this week, have recently appeared in the daily papers, complaining bitterly, and not without apparent cause, of the present unsatisfactory position of a large and useful class of public servants designated "Telegraph Clerks." The duties to be performed are of no ordinary kind. Messages of the highest importance, involving inviolable secrecy and the greatest care in their transmission, are daily and hourly entrusted to these youths, and to their honour be it said that the confidence thus reposed in them has seldom or ever been abused.

They complain that their labours are heavy and irksome, that they are left without encouragement or promotion, and that the remuneration is inadequate to enable them to maintain the respectable appearance which the nature of their occupation renders necessary. We have no means of ascertaining how far these assertions are strictly correct, nor do we wish to interfere in a question in which the employed and the employer are at issue; but such grave statements should not be allowed to pass unheeded.

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Public companies have not, unfortunately, at all times proved to be the best masters, in some cases the individual proprietors and their dependents or workers, are as completely separated from each other as if they belonged to different nations. In some of our large manufacturing establishments, friendly intercourse between the employer and employed is promoted in various ways, and has proved not only highly conducive to the pecuniary success of the former's business, but also to the welfare of their dependents, by whose labour they profit.

With respect to establishments of such magnitude as those of our telegraph companies, whose dependents are enumerated in thousands, and widely dispersed over the face of the whole country, we confess that the above observations are hardly applicable, but still we see no reason why there should not be a closer relation of sympathy, as well as of interest, between the employers of labour in this branch and their subordinates.

To the Editor of the Daily Telegraph.

Sir,—Usually complaints coming direct from those on whom any abuse may fall, do not receive that amount of sympathy or attention they sometimes so much need. Grievances, as we all know, are often magnified by those unlucky enough to have to bear them. Kindly permit me to say a few words on the subject of the bad pay and management of telegraphic clerks. I am now, thank goodness, quite independent of any telegraph company; but having, most unfortunately, served one for nearly ten years, I can vouch for the truth of all that has been said on the subject, in the correspondence which has appeared in your paper during the last few days. In the first place it should be known by all youths who think of seeking a berth in one of these companies, or the parents of such, that if a young fellow becomes a telegraph clerk for any length of time, and devotes his whole attention to it (which his duties will exact from him), when leaving, and applying for a situation in any other capacity, he will find that in every respect, with the single exception of writing, he is incapable of accepting the most subordinate place. And why? A telegraph clerk's entire duty is to receive and forward messages, at whatever instrument he may be stationed, working usually the whole time without intermission, reading from the movements of either one or two small needles, or sending messages at the rate of from twenty to twenty-five words, and often double that number, per minute. The receiving clerk usually suffers from weak eyes, and often has a tendency to squint, which is brought on through constant staring at the rapid movements of the needles. The exertions of the forwarding clerk compel him often to obtain some stimulant, in order that he may be able to get through his pile of work, and avoid being fined; and thus, day after day, do they lose their health, and waste what ought to be the best days of their existence—often, as I know for a fact, for the support of a widowed mother, and perhaps junior brothers and sisters, also for a set of ungrateful directors. Let some one who is a disinterested person, and can gain admission to one of the London instrument rooms of a principal station, do so, and he will there see a motley collection of youths and young men, whose ages vary between twelve and twenty-two. Let him hear the story of each. One little fellow will tell you that he is a "learner," and has to make himself generally useful, and occasionally endeavours to transmit a message to some branch office in town, if the clerk at the other end has sufficient patience to put up with his slowness and many errors, some of which are often received as correct; this lad, mayhap, receives the nominal wages of 2s. 6d. a week. Another, perhaps a little older, will tell you that a short time since he was a messenger, but through the interest of a director in whose service his mother is a cook, he has been promoted to a clerkship—his education having been received probably at some ragged school—but he hopes soon to be able to get on in the company and improve his wretched spelling; as of course the messages are all written, and before him on the instrument desk; and he can easily apply to the better informed clerk in charge, or his writer, if he comes across an unusually long or difficult word. That fine young man in the corner is writer to one of the principal instruments, and has to correctly transmit to paper ill pronounced words from the lips of the crabbed little instrument clerk from whom words are coming at the rate of thirty per minute. He will tell you that he has been in the company since he left school, and has been employed in every department; has always given satisfaction, never was fined, and is now luxuriating on one guinea per week as best writer in the company; he will also tell you that he would have left long since, but could not procure a berth, as his only acquirements are being able to manipulate and write a first-rate hand, and that he is too much knocked up, on reaching home after a day's work, to turn his attention to the cultivation of his mind. He, during the time of being a clerk in charge of an "out station," although only in receipt of the weekly pittance of 17s. 6d., manfully withstood on several occasions, the tempting bribes of people who wanted to glean confidential information they knew him to possess. I could enumerate a host of grievances with which telegraph clerks have to contend, but fear I have already trespassed too much on your valuable space. I sincerely trust that now publicity has been partly given to the shameful organisation and pay of the telegraph clerks, that steps may be taken in the right quarter to thoroughly ventilate the subject, and place this ill-used branch of the community in a better position.—I am, Sir, yours, &c. P.Q.

September 8, 1862.

Telegraphic News.

MESSRS. GLASS, ELLIOTT, and Co., the submarine cable manufacturers of Greenwich, paid for the conveyance, admission, and entertainment of ninety of their workmen to the International Exhibition, on Thursday the 4th inst.

SUBMARINE TELEGRAPH COMPANY—BALANCE SHEET.

Statement of Joint Earnings for the Year ending 30th June, 1862.

Dr.

	£ s. d.	£ s. d.
To amount received for Messages :—		
6 months to 31st Dec., 1861...	17,119 14 8	
Do. 30th June, 1862	18,517 18 8½	
		35,637 13 4½
		£35,637 13 4½

Cr.

	£ s. d.	£ s. d.
By Salaries & Wages:—		
6 months to 31st Dec., 1861	4,631 2 10	
Do. 30th June, 1862	4,472 19 2	
		9,104 2 0
By Gen. Charges, including Clothing, Postages, Auditors' Fees, Maintenance of Batteries, and Incidental Expenses :—		
6 months to 31st Dec., 1861	1,794 6 3	
Do. 30th June, 1862	1,381 3 8½	
		3,175 9 11½
By Rent, Rates, Taxes, Gas, and Insurance :—		
6 months to 31st Dec., 1861	750 15 0	
Do. 30th June, 1862	745 1 4	
		1,495 16 4
By Stationery, Printing, and Advertisements :—		
6 months to 31st Dec., 1861	639 14 7	
Do. 30th June, 1862	294 5 6	
		934 0 1
By Travelling Expenses :—		
6 months to 31st Dec., 1861	403 0 6	
Do. 30th June, 1862	275 1 4	
		678 1 10
By Law Charges :—		
6 months to 31st Dec., 1861		735 10 10
By Repairs to Cables :—		
6 months to 31st Dec., 1861	2,649 2 10	
Do. 30th June, 1862	3,559 1 10	
		6,208 4 8
		£22,331 5 8½
By Profit :—		
Chartered Co.'s Proportion	10,521 14 5	
French Co's. ditto	2,784 13 3	
		13,306 7 8
		£35,637 13 4½

Examined, compared with the Books and Vouchers, and found correct, August 14th, 1862.

GEO. COPELAND CAPPER,
WILLIAM R. COLE,
THOMAS DAKIN,
AUDITORS.

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REVENUE ACCOUNT.—CHARTERED COMPANY.

Statement of Revenue Account from 30th June 1861, to 30th June, 1862.

Dr.	£ s. d.	£ s. d.	Cr.	£ s. d.
To Proportion of Joint Earnings for the year	10,521 14 5		By Interest on Debentures and Loans	3,502 3 5
Less Expenses of Direction	400 0 0	10,121 14 5	By Reserved Fund 10 per cent. on Gross Receipts £28,202 7s. 9d.	2,820 4 9
			By Proposed Dividend	3,179 0 6
			By Balance to New Account	620 5 9
		£10,121 14 5		£10,121 14 5

Examined, compared with the Books and Vouchers, and found correct, August 14th, 1862. GEO. COPELAND CAPPER, WILLIAM R. COLE, THOMAS DAKIN. AUDITORS.

SUSPENSE ACCOUNT.—CHARTERED COMPANY.

Dr.	£ s. d.	Cr.	£ s. d.	£ s. d.
To Reserved Fund	1,410 13 11	By Proportion to be borne by Chartered Company		5,591 16 11
To ditto brought from Revenue Account	2,820 4 9	By Balance of Revenue on Half-year to 30th June, 1861	1,008 18 9½	
To Balance to New Account	2,300 15 11½	Less — Recouped by by French Company	69 1 1	930 17 8½
	£6,531 14 7½			£6,531 14 7½

Examined, compared with the Books and Vouchers, and found correct, August 14th 1862. GEO. COPELAND CAPPER, WILLIAM R. COLE, THOMAS DAKIN. AUDITORS.

BALANCE SHEET.—CHARTERED COMPANY.

Dr.	£ s. d.	£ s. d.	Cr.	£ s. d.
To Capital authorized to be issued	265,000 0 0		By Cables	293,190 3 7
Less — Unissued	53,065 0 0	211,935 0 0	By Sundry Debtors	6,052 10 0
To Debenture Bonds authorized to be issued, one-third of paid-up Capital	70,645 0 0		By Proportion of nett earnings	10,421 14 5
Less — Unissued	25,120 0 0	45,525 0 0	By Balance of Suspense Account	2,300 15 11½
To Loans		35,611 5 0		
To Sundry Creditors		9,161 5 4½		
To Liability on Suspense Account		5,591 16 11		
To Dividends Unpaid		441 10 5		
To Proposed Dividend		3,179 0 6		
To Balance to next Account		620 5 9		
		£312,065 3 11½		£312,065 3 11½

Examined, compared with the Books and Vouchers, and found correct, August 14th, 1862. GEO. COPELAND CAPPER, WILLIAM R. COLE, THOMAS DAKIN. AUDITORS.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

SIR,—A fortnight ago your correspondent "Amicus" declared that a substance cannot be a perfect *insulator* if it have any inductive capacity; but he has since qualified the assertion by explaining that by "insulator" he merely means a suitable covering for telegraph wires. But as that is not the only, or the commonest conventional meaning of the term insulator, he must be now aware that he has, in effect, promulgated a doctrine that he wishes no one to believe. "A Practical Electrician" not perceiving the intended limitation, makes the application of the term an occasion for attack, somewhat unseemly, and withal regretable, as commencing a waste of wit and energy, which has been taken up on the other side, and may be of some continuance. Students in electricity are too few in number, to indulge in those scintillations of genius which burn while they sparkle, live but a moment of profitless existence, and only die never to be forgotten! Better would it have been had "Amicus" written more explicitly, or that writing as he did, "A Practical Electrician" had waited more patiently for explanation. Oh that some Samuel Johnson in electricity, with professional shoulders as broad for responsibility, and a brain as fertile in definition, as those of the great lexicographer, would present to our science a vocabulary which would serve it half as well as he has served the world, that electricity might cease to halt, and electricians to be querulous, merely for default of a common language. Each one of us has now, for almost every significant word, a definition of his own; a plan that makes the general comprehension of a subject extremely difficult, and, after all, necessarily involves a maximum of error.

"A Practical Electrician" asserts that "the more perfect the insulating property of a conductor, the higher generally is its inductive capacity," or, as he would otherwise say in conformity to his implied definitions—the more perfectly is it dielectric. To illustrate by facts this use of terms, he instances a plate of copper, as a substance whose "inductive capacity is *nil*," which is "a very bad dielectric," but a good conductor. A dielectric copper certainly is not, for that expression, in its common acceptation, means a thing that insulates the electricity evolved in its substance by induction; conductivity, however, is no obstacle to induction; we frequently find it liberating the electricity which the induction, sustained by a conductor has made free to leave it: but this relation of induction to the term dielectric does not seem to be generally clear, and perhaps never will become so until the advent of the electrical Samuel Johnson whom we are all waiting for.

"A Practical Electrician" wonders "Amicus" has not learned all about inductive capacity from the columns of the ELECTRICIAN, in which, he says, it "has been clearly explained." "Amicus," if he admit the oversight, will obviously still have a good claim to send his Mentor back to the ELECTRICIAN to discover that in the limited attraction of electricity, there is a cause for inductive capacity in *all* bodies without exception, that surround an electric charge; whether these bodies be dielectrics, by reason of their being insulators, or whether being conductors, the charges induced in them pass away.

RICHARD LAMING.

THE PROGRESS OF TELEGRAPHY.

CAUSE AND EFFECT.

To the Editor of THE ELECTRICIAN.

SIR,—My attention has been drawn to your remarks on this subject, with reference to the half yearly reports of telegraph companies. There are always two sides to a question. I disagree with your views, and think it best to look disagreeable facts fair in the face, rather than the self delusive plan of making things pleasant. When Great Western Railway stock is down to a half per cent. div., business men desire to know the reason why. From a thorough scrutiny the depreciation in telegraph stocks, and the shyness of the public to co-operate therein, could be too easily arrived at; then better let us know the worst if you desire to revive public confidence therein. It is because I believe the subject to be of importance to the nation at large that I care to peep into these Augean stables.

"That a simple, cheap, and expeditious mode of interchanging thought is not less valuable than the present system of railway and marine transit," is an indisputable axiom.

"Commercially speaking, telegraphic enterprise has for sometime been a 'drag on the market,' especially submarine telegraphy;" too true; and why should it be so? We also hear of complaints of ludicrous delays, blunders, and serious mistakes, yet the public have no thought of the large per centage of these drawbacks; as for an unfortunate telegram that may require the aid of the wires of two companies to reach its destination, woe betide it as to accuracy or *lightning* speed of delivery, you might as well expect two Kilkenny cats to come to a working traffic arrangement.

The public, who are they? they pay their money and take their *chance*.

Too many cooks spoil the broth; the telegraph companies are even worse off than some of the railways—overburdened with large directorates upon comparatively small capital, none of whom know enough of the subject to check the jobbing of those under them, whose only interest seem to be to negative any healthy step in the right direction, with a sort of circumlocution office responsibility of how not to do it.

The Electric and International, by their own report, evidently pique themselves on their great sagacity, but apparently blind themselves to that which any one versed in the philosophy of common things cannot fail to see must be a suicidal policy. If this great monopoly can only be maintained by wasting thousands, and attenuating their dividends, merely to bleed their competitors, what sort of trade principles must such a concern stand upon. Notwithstanding your sanguine views, what are the facts? The market value of this company's stock has depreciated, since the coming out of the United Kingdom Telegraph Company, some £120,000 in the agregate, whilst with a dividend of 7 per cent. the market value of their stock is about par; whereas there are on the "Share List" some railways yielding a lesser dividend at 25 to 30 per cent. per annum. By their last report they had spent some £50,000 on a new cable to Holland, and more for extra inland wires to the coast and elsewhere, which with a more enlightened policy might have been saved. When we are informed that their working expenses are nearly 70 per cent. of their earnings, it must be a very problematical advantage increasing the number of their stations so suddenly by 167. They also state they are about the end of their tether as to capital, being at or near their last call on their new stock; consequently when they make further extensions, and require to raise more capital, we will have the mortification of seeing

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them, like others, adopting the attenuating dividend system of preference stock, *simul et semel*, with their natural extension of traffic and business generally. By certain statements in their report they hope to annihilate the United Kingdom Telegraph Company. It is an old saying that those who live in glass houses should not throw stones. It may be quite a fact that neither company can make it pay on long circuits, at a shilling tariff, with the present comparatively slow and expensive mode of working; but the young company (the United Kingdom), has the best of it, although they cannot be expected to show well up at the first start. The suicidal policy of the old monopolists has in another way recoiled on their own heads, for Parliament, to secure to the public the advantage of competition, inserted a clause in the United Kingdom Telegraph Company's Act, when in committee on the Bill, precluding that company from selling or amalgamating with any of the existing companies. The consequence is, the young company must fight on their own hook for an existence, whilst the old monopolists have helped thus to establish upon themselves a perpetual competitive blister that they cannot buy off, but which will knaw into their vitals, and emasculate their dividends.

The United Kingdom Telegraph Company, by their last report, has not yet got the length of a dividend, and which, from the evidence given by the secretary, when in committee on the Bill, appears a long way off, as his evidence went to show that the company was losing at the rate of £6,000 a year at the shilling tariff. It would be but a poor encouragement to the future of telegraphy, if we could not believe that this is but a commencement, and that much of it might be wiped off, especially on the best circuits in England, although this question remains behind: how, if such is the resulting tendency, as between London and Manchester, how much more must that be the case between London and Glasgow?

From your remarks, one would suppose that the British and Magnetic was the most flourishing of concerns: when I look at the "Share List" I find the stock stands at about 50 per cent. dis., with a considerable downdraught of perference stock—dividend at the rate of 10 per cent.

The Submarine Company pay a dividend at the rate of 3 per cent. per annum. How is this downward tendency of dividend to be accounted for, they used to pay 8? If I recollect right, the capital of the first section (the Dover and Calais, A.D. 1851-2,) was £75,000, the contract price of the rope about £9,000, the other expenditures, probably, £4,000: the public were never informed as to where the balance went. The dividend now declared, as compared to what might have been from the foregoing items, is like looking at a thing through a telescope the wrong way.

The Telegraph to India Company, which, with a great flourish of trumpets, proposed to itself to cobble up the *débris* of the Red Sea, or animate a dead donkey, looks very much like a sham—a miniature of the Great Red Sea job where we tax payers were mulct in £800,000 hard cash—and stands a bar to the establishment of any practical and economical system of telegraphic communication between England and India. Pray, what is the amount of this "ample revenue" on the line between "Jubal and Suez," less expenses; and what dividend will that yield on the amount spent on this Utopian cable? I see, by the "Share List," the capital was £100,000, £50,000 called, standing at 50 per cent. dis.

The London District Report, you say, is "very encouraging." Their capital was £60,000, in shares of £5 each; according to the "Lists," £4 15s. paid, is standing at 4 dis., or £80 dis. on £95 paid. The report also goes to show that, although their revenue has been increasing, their expenditure exceeds their receipts by £1,000 a-year. Comparisons are odious, but, methinks, after this there is some hopes for the Great Western Railway and its half per cent. dividend.

The Mediterranean Extension Telegraph Company, I am afraid, it is we poor taxpayers that are the more immediate cause of its appearance "amongst its compeers as a *paying* undertaking;" pray, how many miles of cable have been laid, and how many are now working? I think I know of some 800 miles gone to pigs and whistles, and of some 40, or so, working in one direction; how much more, you will, maybe, inform us.

However paradoxical your remarks may appear, as compared with past facts and results, no one can but feel confident that you write with a strong and hopeful conviction as to the might, could and should be—nay more, will be, of the future progress of telegraphy, and that the past blunderings, though a check in the meantime, is only the forerunner of a more cautious and considerate system for the future. Had I not held the same views as yourself, and felt complete confidence in the future progress of telegraphy, when the science gets purged of the charlatan and jobbing breed so prolific hitherto in telegraphic schemes, I should not have ventured upon such severe and negative remarks. The unscientific blunderings have, doubtless, been most gross, but yet may be taken as warnings to the public in future to select, to follow, and to trust themselves only to the right man in the right place, for such projects in applied science, if they are desirous to avoid attenuated dividends. Then we may expect to see your sanguine prognostications becoming resulting facts, both physically and commercially—the uttermost ends of the earth in daily reciprocative correspondence; the globe covered with wires by land and sea, like the veins in the human system.—I am, your most obedient,

September 5th, 1862. MAGNA EST VERITAS ET PREVALABIT.

To the Editor of THE ELECTRICIAN.

SIR,—The subject of telegraphing having become one of the editorial resources for filling up the columns of the daily papers during the dull season in town, I trust I shall be excused if I occupy your time in the perusal of my remarks upon the social status, habits, and proclivities of the genus telegraph clerk, or employé. If you can find space amongst your more valuable scientific contributions for a letter coming under the department of social science I shall feel flattered that my time has not been spent in vain, as I may be the means of ventilating—to use a cant phrase, a subject which the friends of humanity and progress may probably consider well deserving of their earnest attention.

There is a fatal ambition amongst the more brilliant of the national school children in the rural districts, and I apprehend a not less morbid desire amongst the denizens of urban places of education of all kinds, to rise above the common herd of their fellows in the capacity of an office boy, City clerk, or legal underling, which, I am sorry to say, is too much fostered by those who, with the best wishes for their welfare, ought to be better acquainted with the business habits of the day. I allude more especially to the parochial clergy, both incumbents and curates. These gentlemen are too apt to fasten their affections upon some pretty and intelligent child in their parish school, whose blue eyes and flaxen hair, perhaps, if it be not coal-black orbs and neatly-brushed and combed curls, have elicited the rapturous remarks of the Lady Bountiful of the place, with her bevy of beautiful damsels as they pass upon their daily rounds of charity and lovingkindness amongst the homes of their poorer neighbours. These gentlemen have many pardonable inducements for making pets of such little cherubs, and, after a long and closely continued period of special attention and careful cultivation of their juvenile faculties they congratulate themselves that they have been able to exercise their influence with the managers of telegraphic establishments sufficiently to procure for the interesting object of their regard a situation in an ill-ventilated, or temporary shed, yclept an office, on some lonely, unfrequented portion of the line of railway, where the principal duties of the day consist in making safety (?) signals to the next station as the respective trains have passed, or, on special occasions, assuming an air of interest and importance, as he becomes the means of communication between the squire or nobleman of the district, who telegraphs from the Palace of Westminster or the purlieus of Pall Mall to his loving spouse at the hall, the important information that he shall probably bring down his friend Lord Tom Noddy, or Sir Augustus Fitzfuddle, for a few days' fishing in the trout stream, and that her ladyship's tradespeople in town have the necessary instructions. With such a daily round of duties, interspersed with occasional fresh remarks and equivocal badinage with the railway porters on the station, who, by way of relief to the monotony of their occupation, delight to draw out the shallow wit and senseless slang which the stripling has most readily picked up during the period of his novitiate in the head office in London; who can wonder that the moral tone which the boy acquired during his school days becomes seriously depreciated? and that his intellectual faculties, having only undergone such a measure of training as would fit him to commence an education in some really useful and manly employment as an apprentice to some of the higher branches of artistic trade or manufacture, are daily becoming torpid for want of use, until habits of idleness and inattention begin to replace his former assiduity, and the first application for increase of his pitiful salary is met by the quiet removal to some other more busy station, where he is exposed to the idle conversation of companions in the same state of moral and intellectual laxity, but perhaps in a greatly advanced stage of moral depravity incidental to large towns, and irregular habits of supervision; this is the critical period of his probation, and if he surmounts this, he may look for some more advantageous promotion, so long as he has influential friends, or relations, to support his application for advancement; but if, through his own thoughtlessness, he has forfeited the good opinion of his friends, or from some untoward event he has lost them, woe be to him, he has been wasting the most valuable years of his life, and, perhaps, his health, in unwholesome and offensive dens, which, together with retiring places on railway platforms, are frequently only divided by a light partition, and at last he finds himself a young man in the world with thousands of competitors ready to snap the bread from his mouth, and he without a calling by which he can command employment.

Probably he loses his temper, and in a moment of irritation, or disgust, he loses his place in the company's service, and all his little irregularities rise up in witness against him. What then becomes of our pet child—our pretty boy of the village—does not he find a resource too frequently as marker to a billiard-table, or some occupation amongst his idle associates of a less reputable nature, and more precarious remuneration? Where was the kindness, then, in making a quasi-gentleman of him, in preference to bringing him up as an honest artificer, with fewer personal desires and wishes, but much more real independence and nobleness of feeling? Would it not have been better that he should have cultivated brawny sinews, and vigorous, manly courage, to have carried out to new-made colonies all the highest attributes of the English character? Would not his former patrons rejoice to hear in grateful accents from another shore, the records of his prowess and his successes? who would not be better pleased to grasp the horny hand of the successful emigrant, when he revisits his native country, possibly to carry away with him his long-betrothed pride of the village, and the blessings and good wishes of the playmates and companions of his youth.

But, Mr. Editor, I am afraid you will say all this is out of the pale of your publication; nevertheless, I hope to prove to you, that it is the

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interest and business of the whole community, for as, day by day, the necessity of travelling by railway, and no other conveyance, becomes more unavoidable, so the efficiency of electric communication becomes more urgent and indispensable, to keep pace with the rapidity of transit, and to secure the safety of the travelling public. *Directors* of railways themselves will do well to look to this matter, as they may be sure that where a line is known to be carelessly managed with respect to the safety signals, few people will trust themselves to excursion trains, and fewer still will make a habit of daily consigning their safety to the risks of badly paid, or ill-selected and inefficient signalmen. I must most seriously, and earnestly, call their attention to this department of their management, and at the same time press upon their attention, that in cases in which the safety of life and limb are concerned, no private influence, no considerations of economy should intervene in the selection of the most conscientious, quick witted, and diligent persons for the situations of electric telegraph clerks and signalmen; and that the hours of employment should be so fairly apportioned, that men of mature age should be alone entrusted with this department; and that the wages should be of sufficient proportion to tempt people of character and respectability to undertake the duties of the situation.—I am, sir, yours &c.

PHILANTHROPOS.

September 8, 1862.

To the Editor of THE ELECTRICIAN.

SIR,—A recent experiment, made by myself in conjunction with a friend, who has for some years devoted himself to the pursuit of electrical science, may be productive of interest to at least a section of your subscribers. I would satisfy myself with a simple and unreserved statement of facts, hoping that these may provoke comment from yourself, or discussion among your readers.

Much controversy having arisen between my friend and myself relative to the accelerated growth of plants subjected to electrical agency, and I entertaining close convictions on the subject, I resolved to experiment for myself with such simple means as lay within my power, upon several plants of the ordinary convolvulus. These, during the summer I had raised from seed; and, having selected two boxes of the plants of equal size and health, I placed them in a small greenhouse or conservatory adjoining a drawing-room.

One of these boxes I insulated as perfectly as I could with ordinary tumblers, carefully keeping them dry by wiping them with a silk handkerchief four or five times a day. The other box I placed upon a stand about a foot from the first, but so that both had the same aspect, and might be, as they were, subjected to the same ordinary culture.

I may say, by the way, that the soil in both cases was identical, and the seed from which the plants had been raised the same.

I now proceeded to connect my insulated favourites with the brass conductor of a small plate electrical machine, and old hands and young were but too happy to favour my "crochet" by vigorously turning my machine whenever they chanced to be in the apartment. I was not behindhand in administering several potent charges myself, and I kept watch and ward over the welfare of my flowers with the jealousy of a school-girl.

In three days the plants in the insulated box had far distanced in lusty vegetation their non-insulated neighbours; and in five I was compelled to support them by means of fine sewing silk fastened to iron wires at the top of the conservatory. The less advanced plants in the second box I coaxed upwards in the same way, employing ordinary twine instead of silk.

Notwithstanding the difference in the growth of the plants, those in each box flowered on the same day; but, from this time, the rapid stride made by my insulated pets soon left their earth-tied sisters far behind. The vivid colour of the blooms of the first, as compared with the latter was very remarkable.

I have nothing to add to this brief statement of facts, but I should be glad if any of your readers could throw light upon the subject, even though my own light should then become darkness.—I am, sir, faithfully yours,

C. M. B.

Winchester, September 4, 1862.

THE PERSIAN GULF CABLE.

To the Editor of THE ELECTRICIAN.

SIR,—The patronage extended to india rubber insulation by the Government, is a source of great satisfaction to all true lovers of telegraphic advancement. And it may be considered much more so from the fact that on every department of the state the stigma has not undeservedly been cast of being so reluctant to adopt improvements and inventions, made patent to all the world beside, as being the identical things which every wise man would adopt in the particular circumstances which first gave necessity for their existence. We have been accustomed to look upon our state machinery, and the whole body of our executive, from the plethoric incompetents in high quarters down to the meanest exciseman who waxes eloquent in defence of the constitution at the village alehouse, as being a full half century behind the rest of the country; and that to go a short half-mile from one of the establishments of our merchant princes down to a certain huge building which is supposed to do no end of important business for us, the contrast is as great as though you should leave the bustle and din of the modern Babylon for the drowsy banks of the Nile. The one is all bustle and stirring life, with some one ever at the mast-head on the look out, and fifty down below to make a note of his discoveries, and apply the same advantageously, if worth the trouble; the other has such a somnolent air pervading it, that the old man in old-fashioned spectacles, who is supposed to be in performance of the most momentous duties, not unfrequently takes a long nap in presence of fifty or more individuals, all anxious to be waited on, and make their escape from what is more like an enchanted castle than anything I have seen out of a fairy tale. But now there is a prospect of some of the cobwebs being washed away; and if they would only burn a few hundred miles of red tape, and put such stirring, appreciating, and far-seeing men as Sir W. Brooke at the head of the departments, we should exhibit such efficiency, and capability of grappling with every difficulty, we may, as a nation, have to encounter, as to present no side to the rest of the world which need excite their ridicule. For the matter of that the Government, or rather the country, has paid dear enough for its experience, and people are generally supposed to be wiser, and to profit by an expensive commodity of that sort; indeed, it seems to be the only practical and legitimate method of becoming wise; and certainly £36,000 per annum is a good stiff sum to pay for one miserable sham. I should just like to devote my entire energies to the state for two and a half per cent. per annum upon that amount, and I engage to say they would derive more real service out of me, who am but an ordinary individual, than ever will be rendered to it by the Red Sea Cable.

But we are an uncommonly generous nation, and do not mind the loss of a few hundred thousands if it will help us to the right thing in the end; and really since some very clever men found our ministers napping, and so made them pay for their torpidity to the above-mentioned tune, we must do them justice by saying, that they have been unaccountably shrewd ever since, and do not mean to let the "old soldier" come over them again.

Now these telegraph cable failures are odd affairs, they are something like railway accidents, you rarely get at the truth; and I know of nothing more amusing than to read the guesses or theories of shrewdly-wise persons who endeavour to account for these strange and disagreeable events: and these theories are invariably more clever and sophistical in proportion to the issurance of their individual authors, or the depth of his own complicity in the affair. If he be one of the staff engaged in superintending its submersion, or what not, ten to one if he do not fabricate a fine spun gossamer theory, most beautiful to look at, but specious for the express purpose of throwing us off the scent, and hinder the truth coming to light, which will possibly be damaging to his self interest. And then there is a large class of useful men, ever ready to theorize upon any subject under the sun, so that we get a pretty kettle of fish presented to us, interesting to look upon and anatomize as curiosities, but which practical men blow away, and say, "this is past cure, it is radically defective throughout; we do not pretend to divine the true cause of failure, and it were waste of time to add to the already superabundant speculations, let us begin again and proceed upon rational and common-sense principles."

It is gratifying to find that we have Government men belonging to this practical class, who are desirous of proving to themselves, experimentally, the practicability of successful submarine telegraphy in every climate and under all circumstances; and who, moreover, are wide-awake enough to embrace and appropriate the results of past experience, combined with that effective and advancing progress which is the growth, not unfrequently, of hard work and persevering industry, compatible only, as it would seem, with the comparatively humbler walks of life. Sir W. Brooke seems to have watched over the progress of this cable, this experimental twenty miles for the Persian Gulf, with all the solicitude imaginable; and when a man is so absorbingly interested in the success of an undertaking, as, apparently, to stake his reputation upon it, there can be little doubt as to the issue thereof. And if every man were so devoted to the interest of his country, and I may say the world, as this gentleman, and withal so passionately desirous of the successful application of the discoveries of modern science to the benefit of humanity, we should soon have brought about a state of society more in conformity with things as they should be. A faithful discharge of the duties devolving upon them, and an engrossing interest in the same, is required of every man, especially when occupying prominent and important trusts; and if such satisfactory performance could be calculated upon, the advantages that would accrue would be great; but when a man, who has leave of absence from his onerous duties, is still found taking the same devoted interest in the matter, which forms part of his ordinary occupation when at his post, instead of indulging in the luxurious ease which constitutes the sole end and aim of so many in high stations, the least we can do is to show that we appreciate the same, and feel grateful that we have such men among us, of whom it may be said most characteristically, especially of the gentleman in question, that we have "the right man in the right place."

From the short account given in your last it would appear that the cable is very satisfactorily made, and that it indicates, in every sense of the word, superior workmanship, as evidenced by the results of the severe tests to which it was subjected. I do not think that you have recorded the fact that the core, as it came from the works of Messrs. Wells and Hall, was subjected to Reid's exhaust and pressure test, and that it emerged from that ordeal without suffering the slightest injury. I am the more

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particular in referring to this matter, because of objections which I have seen urged against this method of testing in the pages of the Electrician, and which appear to me to be wholly unfounded, at all events, so far as india rubber insulation is concerned; doubtless there are some grounds for it as applied to gutta percha and its compounds, since, if there be a fault or faults latent, whether in the shape of air cells or anything else, this exhaust pressure will not only find them out but make them worse. But then such things should not exist, and if they do, and such means are not resorted to to discover them, why then your cable will be submerged ready furnished with the means of speedy self-destruction; and I would put it to any man if he would think such a course a wise one, or the venture safe. From my point of view the arguments used against this method of testing are just those which support an opposite conclusion, and unmistakably argue its indispensability. And I consider Mr. Reid is entitled to the gratitude of not only electricians and telegraph engineers, but of the public at large, who must eventually benefit by that which, in the main, secures a good cable, and so saves the public purse from wanton waste.

The manufacture of this infant cable also proves that the requisite skill, energy, and ability exist in other quarters besides those usually had recourse to for the manufacture of submarine cables of an improved description; this is a great point gained, since people are so apt to conclude that because a certain thing is done in a certain place, and by certain people, who have hitherto had it all their own way, that, therefore, all attempts in this same line by others must necessarily prove abortive. As a nation we owe (in part) our greatness in the applications of art, science, and manufacture, to that rivalry of excellence which is the growth of unlimited competition; and I may say that we should not be far wrong in attributing our failures in submarine telegraphy, hitherto, from the simple fact that we have, in this particular, departed from the above custom, and fostered a monopoly, a prejudice, and an exclusiveness which has, therefore, rewarded us according to our desserts. No, in order to secure good cables for the future, there must be a "fair field and no favour." I do not argue in favour of that perverted competition, the offspring of envy and spite, which cuts down the figure of a man's energies to a point at which it will not pay to be just; in cable manufacturing this principle will not do, and those who are for getting them at as low a figure as possible, ought not to require telling that there is a false economy which may be purchased at a far too dear a rate.

I was not one of the privileged few who were favoured with a sight of this cable when in process of sheathing at Mr. Henley's, nor afterwards; but I am informed that this part of the business has been performed with that accustomed care and efficiency which characterizes everything taken in hand by Mr. Henley, who will have to stand upon his own merits in this case, as he does as a manufacturer of some of the most sensitive and inimitable electrical instruments that have been produced.

It is a cause for sincere gratulation, therefore, that a trial is thus to be given to india rubber insulated cables. We may consider this, insignificant as it may appear, to mark an era in ocean telegraphy; and I think we may venture to anticipate that, from henceforth, success in these enterprizes is to be calculated upon with more certainty than failures, since we have men in high positions highly competent to carry out these undertakings, who do not shirk the work, and can appreciate the advantages thrust before them; while, at the same time, the latent energy, skill, and every other quality in man, required for the practical accomplishment of the ideas of an original and intensely concentrating mind, exists in abundance.

Momus.

Miscellanea.

New Electrical Experimemt.—M. Perrot of Rouen has made the following interesting experiment. In a glass vessel filled with oil, or other slightly conducting medium, he mixes by agitation particles of gold leaf, which thus remain in suspension. Into this bath he plunges, at a distance from each other, two ball-conductors, conducting the one with an electric machine, the other with the ground. As soon as the machine is put in motion the currents are seen to form. The fragments of gold move towards the nearest sphere, and after touching extend themselves towards the opposite ball. When these threads of metallic particles are carried out to a sufficient distance, the two currents meet and are arrested, seemingly neutralizing each other, and escaping laterally to return towards their respective balls. If this experiment be made in oil or any other viscid liquid, the particles of gold dispose themselves in lines as regular as those of iron filings round a magnet. When the tension is feeble, the lines formed by the gold particles going off from the two spheres, unite in giving off a spark which illuminates the whole length of the metallic line. Sparks can be thus drawn out a hundred times the length of those got direct from the machine, and are obtained with scarcely any noise. M. Perrot thinks that in this we have an explanation of "heat lightning" as the silent summer flashes are commonly called, which, being produced without noise or tension, are thus to be distinguished from those producing thunder. The position of the neutral point between the two electric balls, depends on the relationship of their respective surfaces. If the balls are equal the neutral point is mid-way; if a point is placed opposite to a ball, the neutral surface establishes itself very near to the latter. This mode of experimentation will probably throw light on some electrical phenomena hitherto very obscure.

To Correspondents.

Thomas. X. X.—We very much doubt, that in any future Exhibition the principle of awarding medals &c., will be resorted too, its absurdity in the case of telegraphy has made itself so manifest, that even those to whom such medals have beem awarded, do not attach much value thereto; and besides, the public generally, thanks to the public press, well know how to appreciate the decisions of interested juries. We do not for a moment doubt the propriety and the justice of awarding medals to inventors and makers of what are called printing instruments, their ingenuity and promised usefulness we readily and cheerfully admit; but in ignoring another class of instruments intended mostly for private and railway telegraphy, the jurors appear to us to have acted not only discouragingly, but unjustly towards the exhibitors. Private telegraphy is rapidly increasing, and the introduction of a simple cheap and efficient instrument is very desirable; the same observation applies to railway signal telegraphs, but because one of the jurors exhibits patented instruments for both the above purposes his coadjutors pass over this important class altogether, with the exception of, in one instance, an honourable mention awarded to Mr. C. V. Walker F. R. S. Those practically acquainted with the operations of telegraphy might have pointed out several other improvements which must lead to the development of the science and which escaped the notice of the jurors, for instance there were batteries, silk and cotton covered wires, cable protectors against lightning, aerial insulators, magneto-electric machine &c.

A Friend of Telegraphy.—The Morse printing instrument was first adopted in Europe, we believe, by the French Government, and soon afterwards by several of the continental Governments. The introduction of the submarine telegraphy between England and the continent brought it into extensive use in this country. Mr. Bains' chemical instrument was extensively used at one time for inland communication, but it never made much progress abroad. The instrument is still employed by the Electric and International Telegraph Company.

A Subscriber.—The South of Ireland Direct Telegraph Company has, we believe, ceased to exist, and its land lines are disposed of to the Electric and International Telegraph Company. The cable was never laid, although a great portion of the core was manufactured by Messrs. Silver and Co.; the conductor was insulated in india-rubber. A cable was submerged between Abermawr in South Wales and the Irish coast by the Electric and International Telegraph Company.

H. M. L.—We are not aware of a friendly cricket match having ever taken place between the directors, shareholders, or officers of any of our rival telegraph companies. We should suggest a rifle shooting match at an electric target, as a more appropriate and diverting amusement for those connected with telegraphy. However, to be serious, it has long been a matter of regret that no efforts are made to establish a more intimate and friendly relation between the members of a numerous and intelligent class of the community—our electro-telegraphists.

P. Q.—The late Mr. John I. Ricardo M. P. became connected with the Electric Telegraph in the latter part of 1845.

Amicus.—You are not correctly informed. A letter of Mr. W. Fothergill Cooke, dated 2nd July, 1837, and which will be found in "Cooke and Wheatstone's Arbitration," part ii. page 130, gives an interesting account of the experiment, and describes the enthusiasm of the young and indefatigable inventor in a very graphic and amusing manner:—"Though having good news to impart, I could not find time till now to write you a few lines; every moment being engaged from six in the morning till ten or eleven at night. On Friday, I called on Mr. Joshua Walker, and imparted my plan for the fire telegraph; he spoke handsomely of it, but recommended my proving the practicability of the general principles, before I attempted to introduce a project involving the disturbance of the pavement. I then expressed my wish to try experiments on the railroad. 'There,' he said, 'I can at once assist you;' and within half an hour introduced me to the Chairman and Secretary of the London and Birmingham Railroad. They both entered warmly into my views, and appointed the following day for a further consideration of the subject. To shorten details, by following up every opportunity that offered itself, and urging forward my suit unceasingly, I got through all the forms, had three interviews with Mr. Stephenson the famed engineer, and got an order for 8 cwt. of copper wire by Friday last; obtained leave to occupy a vast building on the railroad, 165 feet by 100 wide, and had as many men and all the materials I could require placed at my disposal. The order was, 'Let Mr. Cooke have everything he may require.' By strenuous exertions I succeeded in collecting the above vast quantity of wire; cleared the huge workshop of men and lumber, by the constant labour of from 30 to 40 men, and had nearly half a mile of wire arranged by Friday night: proceeding slowly on Saturday morning, having to teach all the men employed, viz., eight carpenters, two wireworkers, and eight boys, their distinct duties, we got forward more rapidly towards evening; and at 5 o'clock, when the men left off work, I had about four miles of wire well arranged, and hope to get all nearly done by to-morrow night. You may imagine the task when I tell you that 2,888 nails have been put up for the suspension of the wires."

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The Electrician.

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CONTENTS:

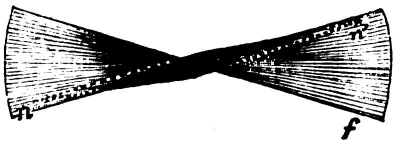
	PAGE
Rotary Galvanometers	229
On Testing Submarine Cables	230
Some Considerations on the Principles of Electrical Conduction and Accumulation	231
Dr. Lardner on the Subjugation of the Powers of Nature to Human Uses	233
Tabular Statement, &c.	234
On Cadmium	234
Recent Patents	235
Prices Current of Insulating Materials	236
Telegraph Shares	236
Telegraphy	236
Professor Hughes' Printing Instrument	236
British Association for the Advancement of Science	236
On the Heat which is Developed, &c.	237
Law Intelligence	238
Telegraphic News	238
Correspondence	238
Miscellanea	240
To Correspondents	240

ROTARY GALVANOMETERS.

THE problem of producing the rotation of a magnetic needle, by means of its continued deflection under the action of a voltaic current, traversing several wires similarly disposed in relation to the needle, is one which has often engaged the attention of the experimenter in electricity. Unfortunately, it is but seldom that any details are published of "unsuccessful" experiments; and it is for this reason that the same ground is constantly being trodden, again and again, by those who are labouring in the same field of research. This would not be the case if the fact were duly appreciated, that an experiment giving a negative result may often be of at least equal value with that which verifies the preconceived notions upon which the experiment may be based. In the explanation of "unsuccessful" experiments, may frequently be involved new discoveries or a deeper insight into the operation of natural agencies; and we may, therefore, take this opportunity of requesting those of our readers who are engaged in any branch of electrical research, to favour us with the details of such experiments—as well as of those confirming an anticipated conclusion, when opportunity offers, in order that others may profit by what might be considered, in a practical point of view, as failures, attended with a considerable loss of time and expenditure of energy, but which may be, nevertheless, of some value to the scientific inquirer.

Most persons who have constructed a galvanometer, or considered the principle of its action, have, probably, been struck with the idea of rendering the effect continuous by the means to which we have adverted. For certain purposes, such as measuring the "discharge" of electricity accumulated in submarine conductors under various conditions, the "rotary galvanometer" might possibly prove a valuable instrument of research. It is, however, simply as an interesting practical application of electrical principles, that the student in most cases would be inclined to consider the construction of such an instrument. A step may be taken in this direction by coiling the wire of ordinary galvanometers as indicated in the following figure, showing the coil in plan.

Fig. 1.



The turns of wire, instead of being parallel, are made to cross each other, and are spread out at the extremities of the coil. By this means, when the direction of the current is such as to deflect the needle in the direction from *n* to *f*, the amplitude of the deflection may be considerably increased. It should be stated, that the method in question is adapted for short lengths of wire, and for instruments intended for the detection of currents of low tension. It is obvious, however, that it does not supply the means for obtaining the rotation of the needle, though the deflection may be considerably over 90°, the *maximum* in galvanometers of the ordinary construction.

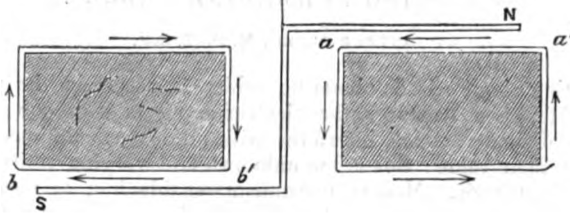
The following plan, which has occurred to several experimenters, appears, at first sight, to give the theoretical conditions under which this effect might take place. In the centre of a disc of wood or gutta percha, about five inches in diameter and one inch thick, a circular aperture was made, about one inch in diameter. Round the flattened ring thus formed was coiled several hundred yards of insulated copper wire, the turns being, as nearly as possible, in the direction of radii from the centre of the disc. A short piece of straw, attached to a fibre of silk, was suspended in the centre of the aperture within the coil, and was kept in this position by means of a brass pin passing upwards within the lower portion of the straw. A steel needle, magnetized to saturation, was then inserted horizontally into the straw, above the disc, so as to be perfectly parallel with the wire of the coil, and was balanced by a brass pin of equal weight. A needle similarly suspended above a single wire conveying a voltaic current was found to be deflected, an effect due to the resolution of forces acting upon the needle, which had been anticipated. It was supposed, therefore, that the needle suspended above the disc, in such a position as to be continuously under the influence of currents in a determinate direction from one pole to the other, would, as a necessary consequence, acquire a movement of rotation around its fixed pole. The presumption was, however, negatived by the experiment. When a powerful current was passed through the coil, the needle was seen to start and vibrate under the electric influence, sometimes moving through a small space in either direction, but evidencing no tendency to continuous rotation. Moreover, it could be brought to rest indifferently over almost any point of the periphery of the disc.

The experiment, despite its negative result, is an interesting and instructive one. We will, for the present, leave its explanation open to the electrical student, and proceed to describe some other attempts in the same direction.

It was considered by another experimenter more satisfactory to suspend a magnet in such a manner as to allow of its rotation about its centre. For this purpose a piece of steel wire six inches in length, was bent twice at right angles, so that when suspended within the aperture of the coil $2\frac{1}{4}$ inches of its length might be disposed horizontally above the disc, and a similar portion below. The wire was then hardened and magnetized, as nearly as possible to saturation.

It will be seen by the following diagram, that no movement of rotation could be expected when this magnet was suspended within the above coil—a section of which is given, showing the direction of the current in the turns of wire at opposite points of the frame upon which the wire was wound.

Fig. 2.



In this case the current in the portions of wire *a a'* and *b b'*, respectively *below* and *above* the magnetic needle, is in the same direction in regard to the poles of the magnet, *i. e.*, from the north pole to the south pole. But we know that a current in this direction, traversing a conductor placed above the whole length of the magnet, will deflect the latter, causing the north pole to move eastward and the south pole westward. The same current passing below a magnet, or portion of a magnet, as at *a a'*, will have the contrary effect of tending to deflect the north pole towards the

west. In endeavouring to obtain the effect of rotation, it was necessary, therefore, to adopt a different mode of construction in the coil.

In the following short table, which will be found convenient for reference, we have endeavoured to state in the most simple manner, the sense of the deflection of the horizontal magnetic needle, under various conditions which constantly recur in practice.

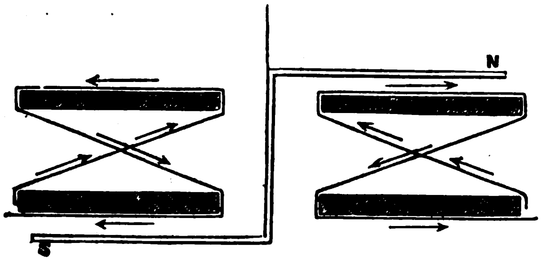
The indicated deflection is that which would appear to an observer facing the south pole of the magnet.

Position of the Conductor in relation to the Magnetized Needle.	Direction of the Current in relation to the Poles of the Magnet. From	Deflection of North Pole of the Magnet. To
1. Below	North to south	Left
2. „	South to north	Right
3. Above	North to south	Right
4. „	South to north	Left

In the above figure, the conditions under which the current effects respectively the portions of the needle above and below the coiled ring, are given in cases, No. 1 and No. 3.

The coil, within which the bent magnetic needle was suspended (by means of a single fibre of silk), was constructed as follows:—Two flattened rings of *thin* gutta percha, in other respects of the same dimensions as the preceding, were united together in superposition by means of several pieces of gutta percha attached to the upper and under surfaces in the direction of radii from the centres of the disc, which were thus maintained nearly one inch apart. The following diagram represents in section the double ring, and the mode of coiling the wire.

Fig. 3.



In the table given above the conditions which, in this arrangement, affect the north and south extremities of the magnet respectively, are given in No. 2 and No. 3 cases, and combine to produce the deflection of the needle in a determinate direction.

A negative result, precisely as in the former case, was obtained when a voltaic current traversed the wire.

(To be continued.)

ON TESTING SUBMARINE CABLES.

BY LATIMER CLARK, M. INST. C.E.

In testing single-wired submarine cables to ascertain the position of faults or fractures, the electrician meets with one well-known difficulty, which interferes with all his calculations and impairs their value; this is the unknown and varying resistance of the fault itself. Modern instruments enable him to measure with the utmost accuracy and facility the joint resistance of the conducting wire and the fault, but there is no means of ascertaining how much of this total resistance is due to the one and how much to the other, and without this knowledge the locality of the defect cannot be determined. A particular instance of this occurred in the case of the late Atlantic cable; all who tested the cable at Valentia found the actual resistance of the line to be equal to about 250 miles, but formed very various opinions as to the position of the fault, some believing it to be at the full indicated distance, and others imagining it to be near at hand, the real question at issue being simply the amount of resistance due to the fault itself. A rough idea of the magnitude of a fault is indeed obtained by observing the varying resistance it exhibits when tested with alternate positive and negative currents, but it is of the most vague and general character, and the measurement does not admit of numerical determination.

In endeavouring to overcome this difficulty I have observed the somewhat singular phenomenon, that, although the resistance of a copper conductor remains constant, whatever the number of cells of the battery employed, the resistance of water does not do so, but varies greatly according to the greater or less tension of the battery, and I have been able to base on this a method of measuring the resistance of a distant fault, which I have found of great practical utility to myself, and which, I venture to hope, will prove so to others.

The following table will show the extent to which this variation takes place. In forming it ten different specimens, representing faults, were made from percha wire, the smallest exposing only the transverse section of the conducting wire, which was of No. 16 copper, and the largest exposing three inches in length of the wire; these were immersed in the sea, and their resistances measured with batteries of different power, varying from one cell to sixty cells of Daniell. The positive pole of the battery was in every case connected to the earth, and the negative to the cable. The resistances are given in Siemens' mercury units; it will be noticed that the resistances with a single cell are variable and uncertain, but the others form a very regularly increasing series, and they were found very uniform with different wires:—

Negative Current.	Section of No. 16 Copper Wire.	1-16th	⅛	¼	⅜	½	¾	1 inch	2 inches	3 inches
1 cell ...		5970	5900	2000	2009	2000	1800	2000	800	?
3 cells...	400	235	212	190	180	170	159	147	143	135
6 cells...	182	102	91	82	76	72	66	64	60	59
12 cells...	119	57	49	41	38	36	33	32	30	29
24 cells...	90	41	34	28·5	25	23	20·5	20	18·5	17·5
36 cells...	85	37	30	24	21	19	17	15·5	15	13·5
48 cells...	82	36	29	23	20·5	18	17	16	14	12·2
60 cells...	84	34	26	21	18·5	17	155	14·2	12·2	11

In forming the foregoing table no resistance was interposed between the battery and the fault except that of the galvanometer used in the measurement; but on experimenting further it was found that the addition of a varying length of conducting wire between the battery and the fault greatly affected the ratio of the resistances shown by different battery powers, and ultimately it was found necessary to construct a table using a series of artificial faults of graduated magnitude, and interposing varying resistances to represent those of the conductor of the cable and the galvanometer, and in each instance using battery powers of six and of sixty cells. This table is given below, but, having been hastily constructed at sea, it is imperfect, and has no pretension to great accuracy, it was, nevertheless, found of great utility, and enabled one, in all cases, to ascertain with certainty the locality of the defects in the injured cable. The upper columns give the resistances of the faults alone measured on short circuit; the succeeding columns give the resistances of the same faults when additional resistances were inserted; but it is to be particularly noted that in every case there was also the interposed resistance of the half coil of the differential galvanometer = 144 units. In using this table the resistance of the defective cable is measured with 60 cells and with 6 cells, and the one quantity being subtracted from the other gives a certain difference, and a comparison of these three quantities with the corresponding values in the table enables one to identify the magnitude of the fault, and see the ratio between its resistance and that of the line.

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Resistance of Fault on Short Circuit.

Daniell's battery.	Section of No. 16 Wire.	1-16th inch in length.	⅛ inch.	¼ inch.	⅜ inch.	½ inch.	¾ inch.	1 inch.	2 inchs.	3 inchs.	6 inchs.
6 cells	182	102	91	82	76	72	66	64	60	59	54
60 cells	84	34	26	21	18·5	17	15·5	14·2	12·5	11	10
	98	68	65	61	57·5	55	50·5	49·7	47·5	48	43·5
With 50 Units interposed.											
6 cells	234	167	153	145	139	137	132	130	124	123	115
60 cells	130	84	87	72	68·5	67	66	65	62	62	60
	104	83	66	73	70½	70	66	65	62	61	55
With 100 Units interposed.											
6 cells	310	234	219	213	208	203	195	192	186	185	170
60 cells	190	137	130	124	122	120	119	118	116	115	114
	120	97	89	89	86	83	76	74	70	70	56
With 200 Units interposed.											
6 cells	460	372	357	342	338	331	320	317	314	309	291
60 cells	290	240	233	228	225	224	222	221	219	218	215
	170	132	124	114	113	107	98	96	95	91	76
With 300 Units interposed.											
6 cells	600	500	485	470	460	453	445	440	435	427	410
60 cells	395	345	335	330	326	326	725	324	322	320	317
	205	158	150	140	134	127	120	116	113	107	93
With 400 Units interposed.											
6 cells	735	625	619	590	585	575	562	557	550	545	522
60 cells	507	455	450	450	448	448	447	449	448	445	443
	228	170	169	140	137	127	115	108	102	100	79
With 500 Units interposed.											
6 cells	930	820	800	775	760	747	740	730	720	708	697
60 cells	620	570	566	562	560	559	558	558	557	556	553
	310	250	234	213	200	188	182	172	163	152	144

Each operator should form such a table for himself using his own accustomed instruments, and a more uniform graduation of the faults, employing either three or four cells for the minimum, and as large a maximum as can be conveniently carried. As the quantity of electricity considerably affects the result it is desirable to employ batteries of a uniform size. The measurements may be conveniently made in a small vessel of sea-water, which should be, however, frequently changed, and such experiments are very interesting; it is most instructive to watch the rapid formation of oxide of copper at the positive pole, and the rapid evolution of hydrogen at the negative; for this purpose about a quarter of an inch of wire may be exposed—if the wire be bright and traversed by a negative current it will give a certain resistance, say 30 units; if the current be now changed to positive no increase of resistance will take place for a considerable time, although the wire oxidizes rapidly, if, however, the current be reversed or interrupted, even for the most minute fraction of a second and again applied, the resistance will then suddenly increase to 1000 or upwards, and will do so ever afterwards. If it, however, be left disconnected for a minute or longer, it will regain its original resistance, and, even with the positive current, will, at the first moment of contact, give a resistance of 30 units as before, but in an almost inappreciable instant of time, it will rise again to its old maximum of 1000; and if the operator at the time be using a counterbalancing resistance of the same amount the sudden throw of the needle to one side, followed by its rapid settlement to zero, so exactly resembles the appearance of an inductive charge entering into a long cable that the most practised experimenter might be deceived. The positive current covers the wire with a whitish, metallic-looking oxide, but if the current be reversed this coating immediately turns black and falls off in flakes; the longer the length of wire the more slowly this change takes place; as soon as it is completed, *and not before*, abundant bubbles of hydrogen gas rise from all parts of the surface, and these phenomena, which may be alternated at pleasure, are accompanied by remarkable changes in the resistance. The positive current polarizes the wire, and causes it to give a strong current with ordinary copper, the negative current causes it to give a current in the opposite direction, that is to say, from the polarized copper through the liquid to normal copper, thus causing it to behave like zinc, in fact, it becomes even positive to zinc itself; this effect, which is obviously due to the presence of a thin film of hydrogen, is very evanescent, but it lends a corroboration to the theory that hydrogen is iself a metal.

These phenomena are well worthy of an attentive study.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

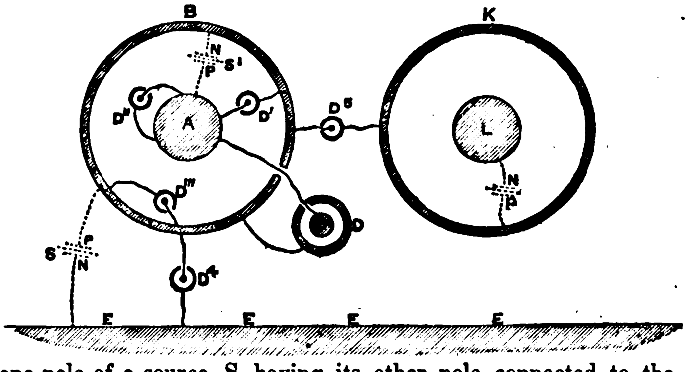
[Continued from page 209.]

I WILL now attempt to illustrate and define the sense in which I intend to employ the word "tension." In so doing I trust I may not add to that confusion of terms to which I have just alluded.

Electrical excitation may be said to consist, in some point of a body being out of electrical equilibrium with some point of another body, so that when those two points are joined by a conductor, the electrical equilibrium will tend to restore itself, producing the phenomenon termed an electric current. When an insulated conductor is charged in any way, equilibrium between all points situated in that conductor, therefore, very soon occurs, since all points are in conductive connection. But although equilibrium is soon arrived at between any two points in the conductor, yet every point in it will, as long as the conductor remains charged, be out of equilibrium with some other conductor or conductors, although not necessarily with *all* other conductors.

Thus, if B (fig. 91), be an insulated conductor charged from

Fig. 91



one pole of a source, S, having its other pole connected to the earth, then all points in B will soon be in equilibrium to one another, but no point in B will be in equilibrium with any point in the earth; and if B is joined by a conductor to the earth conduction would ensue; the two equal and opposite quantities neutralizing each other. But if B, being a hollow shell, is charged from one pole of a source, S′, having its other pole connected to the sphere A, contained within the shell, then the sphere and shell will receive equal quantities of opposite electricity, and consequently the shell B will not be in equilibrium to the sphere A; but B will, as long as A remains within it, and unconnected with any body external to B, still be in perfect equilibrium to the earth.

If a conductor A is entirely surrounded by another conductor or shell, B, and the two are kept constantly in the same position, then the accumulation on the interior conductor must be the result of a departure from equilibrium between the conductor A and the surrounding shell B, and consequently the quantity on the sphere A is proportional to, and a measure of the departure from equilibrium between A and B, or in fact, since we suppose all the conditions of the case the same as regards the size and

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distance of the conductors, the quantity on A is a measure of the electrical force existing between any point in A, and any point in B, tending either to produce current or accumulation. If we could measure the quantity on A, therefore, in two successive experiments, we should obtain information of the proportionate electrical force existing between A and B, and consequently also between all points in equilibrium with each of them.

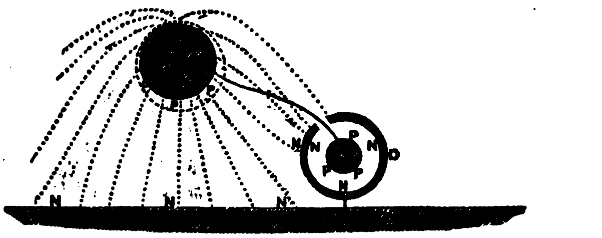
Suppose now C to be a small sphere, surrounded by a shell D, and let the spheres C and A be connected together, and the shells D and B connected together. Then it is evident from what has preceded, that the quantity on A will divide itself with C, in the inverse ratio to the inductive resistances separating A from B, and C from D. If the quantity on A is increased, everything else remaining the same, the quantity passing to C will be increased; and if the inductive resistance separating A from B is increased, the quantity passing to C will also be increased.

In these cases the quantity passing to C is altered through an alteration of conditions, which can be easily traced; we could, knowing the quantity imparted to A, and the inductive resistance between A and B, and between C and D, predict the quantity that will pass to C. Still the quantity on C becomes a measure of the electrical force existing between C and D, and since C is in equilibrium with every point in A, and D is in equilibrium with every point in B, it becomes a measure of the forces existing between every point in A, and every point in B.

In this case, as in many others, the quantity passing to C is simply the result of a redistribution according to the inductive resistance separating the two opposite states, and as long as these resistances are distinct, I shall show further on that a simple and definite relation exists between the quantity, the inductive resistance, and the electrical force existing between points in the different bodies, which is of great use in solving a number of interesting problems. There are other cases, however, which from the complication of the conditions, and the indefinite form of the resistances, cannot be thus traced, which would possibly even defy the most elaborate mathematical analysis. Yet still, if the body C be connected to any point in such a system, and the shell D to another, if those points are not in electrical equilibrium, accumulation on C, and on the interior of D will result, and the quantity on C will become as in the other case, a measure of the electrical force existing between C and D, and consequently between all points in equilibrium with C, and all points in equilibrium with D.

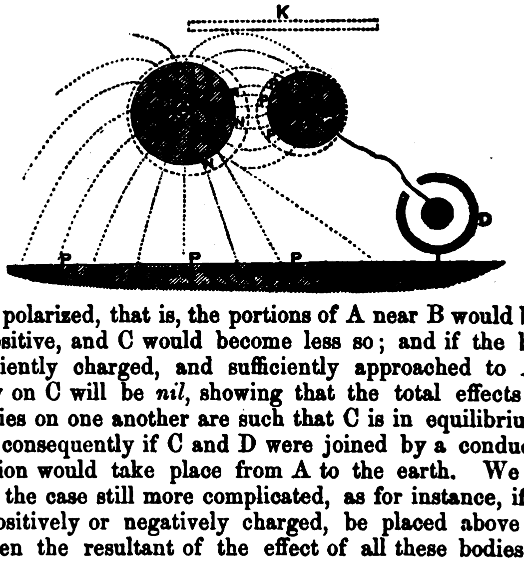
Thus, for instance, suppose A (fig. 92), to be a conductor

Fig. 92.



charged from the positive pole of a source, the negative pole of which is connected to the earth, then a certain positive quantity will pass to the conductor, and an equal negative quantity to the earth. Suppose the source now withdrawn. If A be now connected to C, then a certain quantity will pass from A to C. If we could express the inductive resistance between A and the earth in the same terms as the resistance between C and D, then we could predict the quantity that will pass to C; but we cannot trace, by any principles that have been mentioned, the relation of the resistance between the body A and the earth, to the dimensions of that resistance. In the first place, because the dimensions of the resistance are indefinite, and in the second because we cannot tell to what extent the inductive action is carried on in curved lines between A and the earth, which would probably take place in lines somewhat as represented in the figure. Yet although we cannot assign the relation that exists between this resistance and its dimensions, it still *has* a certain resistance, and the quantity passing to C will depend on the proportion of this resistance to that between C and D. Here, therefore, we cannot trace the relation between these resistances, yet still the quantity on C will be proportionate to the electrical force existing between C and D, and consequently measures also the electrical force existing between A and the earth. If A be raised higher from the earth, the inductive resistance between A and the earth will be increased, and the quantity passing to C increased, and we should know by the quantity passing to C that the electrical force between C and D had been increased, and consequently that between A and the earth. If we now placed near A a large body, B (fig. 93), which had been previously negatively charged, from a source having one pole to earth, with a much greater quantity than A, the whole conductor A C would

Fig. 93.



become polarized, that is, the portions of A near B would become more positive, and C would become less so; and if the body B is sufficiently charged, and sufficiently approached to A, the quantity on C will be *nil*, showing that the total effects of the two bodies on one another are such that C is in equilibrium with D, and consequently if C and D were joined by a conductor no conduction would take place from A to the earth. We might suppose the case still more complicated, as for instance, if a flat plate, positively or negatively charged, be placed above B and A. Then the resultant of the effect of all these bodies would leave C either neutral, positive, or negative, and the quantity on it would measure the electrical force existing between C and D, and consequently between A and the earth. And in the same way, however complicated the conditions of the case are, the final quantity on C and D measures the electrical force between C and D, and consequently between any points then in equilibrium with them.

It may, therefore, be generally stated that: *Between any two points which are not in electrical equilibrium to one another, there exists a mutual electrical force tending to cause a movement of electricity between them, so that when those points are joined by a conductor conduction ensues, and when each is joined to one of two conducting surfaces, opposed to one another, and separated only by a dielectric, accumulation on those surfaces. This force constitutes the* TENSION *between those points, and is proportional to the quantity of electricity accumulated on one of two conducting surfaces, opposed only to one another, each connected to one of those points, and separated by a given inductive resistance, or two surfaces of given area, and separated a given distance by a given dielectric.*

If, therefore, we take an electrometer, such as represented in fig. 89, and connect the arms to any point in A, (fig. 91), and the armature to any other, B, then the inductive resistance between the arms and the armature being constantly the same, the tension between A and B will be proportional to the quantity on the arms, and since it has been shown how to measure the quantity on the arms, we have the means thereby of measuring the pro-

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portionate *tension* between any two points, as compared to that between any other two.

Thus if we connected the arms to A, and the armature to B, as at D, we should measure the tension between A and B, or if placed at D′, we should measure the same. If placed at D^4, we should measure the tension between B and the earth.

When an electrometer is thus connected to two points, and we obtain no accumulation in the arms, and consequently no effect, it shows that those points are in equilibrium, or in fact there is no tension between them; but it does not in the least follow that the conductors in which those points are situated are both uncharged conductors, or that both even have the same quantity of electricity on them, or even that they are charged with electricity of the same name. Thus, if A is charged positively from a source S, having its other shell connected to the shell B, then an electrometer at D^4 would give no indication, although the shell B has received a definite charge of negative electricity, but has only a tension to A. If A be removed from the shell B, then B would instantly be in a state of tension to the earth, and the electrometer E^4 would be affected. If the electrometer has both parts connected to A, as at D″, no indication would take place, although the sphere A is positively charged, showing that all parts of A are in equilibrium to one another. Again, if both parts be connected to B the same would result. Again, if we suppose another sphere, L, surrounded by a shell K, then if L is charged negatively from one pole of a source, having its other pole connected to K, so that the shell K receives a positive quantity, then if the arms of an electrometer D^5 be be connected to the negatively charged shell B, and the armature to the positively charged shell K, no indication would ensue, showing that B has no tension to K.

It is evident that it is not sufficient to state the degree of tension between two bodies, but that it is necessary also to state which is positive and which negative, thus in the case of A being charged positively from the source S, we should say A had a certain positive tension to B, and that B had a negative tension to A.

(*To be continued.*)

DR. LARDNER ON THE SUBJUGATION OF THE POWERS OF NATURE TO HUMAN USES.

Each succeeding age and generation leaves behind it a peculiar character, which stands out in relief upon its annals, and is associated with it for ever in the memory of posterity. One is signalised for the invention of gunpowder, another for that of printing; one is rendered memorable by the revival of letters, another by the reformation of religion; one is marked in history by the conquests of Napoleon, another is rendered illustrious by the discoveries of Newton.

If we are asked by what characteristic the present age will be marked in future records, we answer, by the miracles which have been wrought in the subjugation of the powers of the material world to the uses of the human race. In this respect no former epoch can approach to competition with it.

The author of some of the most popular fictions of the day has affirmed, that in adapting to his purpose the results of his personal observation on men and manners, he has not unfrequently found himself compelled to mitigate the real in order to bring it within the limits of the probable. No observer of the progress of the arts of life, at the present time, can fail to be struck with the prevalence of the same character in their results as that which compelled this writer to suppress the most wonderful of what had fallen under his eye, in order to bring his descriptions within the bounds of credibility.

Many are old enough to remember the time when persons, correspondence, and merchandise were transported from place to place in this country by stage-coaches, vans, and waggons. In those days the fast coach, with its team of spanking blood-horses, and its bluff driver, with broad-brimmed hat and drab box-coat, from which a dozen capes were pendant, who "*handled the ribbons*" with such consummate art, could pick a fly from the ear of the off-leader, and turn into the gateway at Charing Cross with the precision of a geometrician, were the topics of the unbounded admiration of the traveller. Certain coaches obtained a special celebrity and favour with the public. We cannot forget how the eye of the traveller glistened when he mentioned the Brighton "Age," the Glasgow "Mail," the Shrewsbury "Wonder," or the Exeter "Defiance;" the "Age," which made its trip in five hours, and the "Defiance," which acquired its fame by completing the journey between London and Exeter in less than thirty hours.

The rapid circulation of intelligence was also the boast of those times. How foreigners stared when told that the news of each afternoon formed a topic of conversation at tea-tables the same evening, twenty miles from London, and that the morning journals, still damp from the press, were served at breakfast within a radius of thirty miles, as early as the frequenters of the London clubs received them.

Now, let us imagine that some profound thinker, deeply versed in the resources of science at that epoch, were to have gravely predicted, that the generation existing then and there would live to see all these admirable performances become obsolete, and consigned to the history of the past; that they would live to regard such vehicles as the "Age" and "Defiance" as clumsy expedients, and their celerity such as to satisfy those alone who were in a backward state of civilization!

Let us imagine that such a person were to affirm that his contemporaries would live to see a coach like the "Defiance," making its trip between London and Exeter, not in thirty, but in five hours, and drawn, not by 200 blood-horses, but by a moderate-sized stove and four bushels of coals!

Let us further imagine the same sagacious individual to predict that his contemporaries would live to see a building erected in the centre of London, in the cellars of which machinery would be provided for the fabrication of *artificial lightning*, which should be supplied *to order*, at a *fixed price*, in any quantity required, and of *any prescribed force*; that *conductors* would be carried from this building to all parts of the country, along which such *lightning* should be sent at will; that in the attics of this same building would be provided certain small instruments like barrel-organs or pianofortes; that by means of these instruments, the aforesaid lightning should, at the will and pleasure of those in charge of them, deliver messages at any part of Europe, from St. Petersburgh to Naples; and, in fine, that answers to such messages should be received instantaneously, and by like means: that in this same building offices should be provided, where any lady or gentleman might enter, at any hour, and for a few shillings send a message by *lightning* to Paris or Vienna, and by waiting for a few moments, receive an answer!

Might he not exclaim after the inspired author of the Book of Job:—

"Canst thou send lightnings, that they may go, and say unto thee, Here we are!" xxxviii., 35.

But, suppose that his foresight should further enable him to pronounce that means would be invented by which any individual in any one town or city of Europe, should be enabled to take in his hand a pencil or pen, the point of which should be in any other town or city, no matter how distant, and should, with such pen or pencil, write or delineate in such distant place, such characters or designs as might please him, with as much promptitude and precision as if the paper to which these characters or designs were committed lay upon the table before him; or that an individual pulling a string at London should ring a bell at Vienna, or holding a match at St. Petersburgh should discharge a cannon at Naples!

Suppose he should affirm that means would be discovered for converting charcoal into diamonds; that the light of the sun would be compelled, without the intervention of the human hand, to make a portrait or a picture, with a fidelity, truth and precision, with which the productions of the most exalted artistic skill would not bear comparison; and that this picture should be produced and completed in its most minute details in a few seconds—nay, even in the fraction of a second; that candles and lamps would be superseded by flame manufactured on a large scale in the suburbs of cities, and distributed for use in pipes, carried under the streets, and into the houses and other buildings to be illuminated; and that the precious and other metals being dissolved in liquids, would form themselves into articles of ornament and use by a spontaneous process, and without the intervention of human labour!

No authority however exalted, no attainments however profound, no reputation however respected, could have saved the individual rash enough to have given utterance to such predictions some forty years ago, from being regarded as labouring under intellectual derangement. Yet all these things have not only come to pass, but the contemplation of many of them has become so interwoven with our habits, that familiarity has blunted the edge of wonder.

Compared with all such realities, the illusions of oriental romance grow pale; facts stand higher than fiction in the scale of the marvellous; the feats of Aladdin are tame and dull; and the slaves of the

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lamp yield precedence to the spirits which preside over the battery and the boiler.

Of all the physical agents discovered by modern scientific research, the most fertile in its subserviency to the arts of life is incontestably electricity, and of all the applications of this subtle agent, that which is transcendently the most admirable in its effects, the most astonishing in its results, and the most important in its influence upon the social relations of mankind, and upon the spread of civilization and the diffusion of knowledge, is the electric telegraph. No force of habit, however long continued, no degree of familiarity can efface the sense of wonder which the effects of this most marvellous application of science excites.

TABULAR STATEMENT OF THE APPROXIMATE EXTENT OF COUNTRY COVERED BY THE SEVERAL DESCRIPTIONS OF VEGETATION IN VICTORIA.

The statements contained in this article will prove interesting to those engaged in coating electrical conductors.

	Acres.
Morasses, Lakes, and Lagoons...	402,000
Dense Mallee Scrub	5,560,000
Mountain Ranges densely wooded with Gum ...	6,225,000
Opened Timbered Country	38,922,000
Open Plains devoid of Timber, including Heaths ...	4,470,000
Tea-tree Scrub	65,000
Total	55,644,000

From the foregoing table it will be seen that about 12,000,000 acres of land, namely the mountainous tracts, and those covered with Mallee and Tea-tree Shrub, are densely clothed with myrtaceous vegetation, in the foliage of which enormous quantities of valuable volatile oils are stored.

The suitability of these substances for the manufacture of varnishes has been frequently referred to already; in addition it may be remarked that most, if not all, of the refractory resins which are but little acted upon by them at ordinary temperatures yield to their solvent action, when previously fused in the manner commonly practised by varnish makers.

Gutta percha, which is not affected by a lengthy digestion in the cold, is easily taken up when the temperature is raised, although a large portion appears to be again deposited when the liquid has cooled and remained for some time in a state of rest. The most exceptional, and important property which the Victorian oils exhibit in their relations with resinous substances, is the power they possess of dissolving the fossil Kaurie Gum (Damara Australis), of New Zealand. This substance can be obtained at a very low price, from £10 to £12 per ton; but the difficulty of bringing it into perfect solution has hitherto retarded its exportation in large quantities. The solution of the above-named resin, bears dilution with very strong alcohol, ether, and chloroform to any extent, and about 30 per cent. of turpentine may be added with safety; but 50 per cent. of that solvent throws down the resin as does spirits of wine, benzine, linseed oil, and coal oil (kerosene). The solution of sandarac may be diluted with strong alcohol; but turpentine and linseed oil cause the deposition of the resin. Asphaltum is thrown down by absolute alcohol; but turpentine may be added with impunity. Grass-tree resin, on the contrary, is held in solution by alcohol, but will not bear dilution with turpentine or linseed oil. Mastic may be diluted with all the ordinary solvents, but alcohol in quantity appears to precipitate a portion, giving rise to a milky appearance.

With a view of testing the durability of varnishes prepared with essential oils of the genera Eucalyptus and Malaleluca, many experiments have been undertaken; numerous surfaces coated with them, and with varnishes of established reputation, have been placed in sheltered and exposed situations, and the effects of sun and moisture, and of shade, compared and noted from time to time; but the results obtained are as yet too imperfect to admit of their embodiment in the present report, investigations of the kind requiring much time for their satisfactory completion.

ON CADMIUM.

BY B. WOOD, M.D.

The properties of cadmium appear to have been less clearly determined by chemists and metallurgists than those of most other metals. Discrepancies exist in regard to it; while some of its most remarkable, if not most useful, properties are not at all noticed, at least by the generality of authors, even when explicit and elaborate as to similar properties possessed by other metals. Our ordinary works on chemistry treat of the metal very briefly as of little importance; one of the latest says, "it has *no* practical value in the arts;" but if duly investigated it will be found, I think, to possess qualities highly useful to the arts, as well as interesting to science.

The melting point of cadmium is variously stated by authors. Some place it indefinitely, "below a red heat." Overman, in his "Treatise on Metallurgy," marks it at 550° F., and indicates 600° as the temperature at which the metal volatilises. Brande ("Dict. Science and Art") says, "it fuses and volatilises at a temperature a little below that at which tin melts." Webster ("Manual of Chemistry") states that "it melts and volatilises by a heat not much greater than that required to vaporise mercury." Most of our chemical text-books put its melting point at 442° (from Stromeyer); while the *New American Cyclopœdia*, now in course of publication, places it, on the the authority of Daniell, at 360° F.

It would be interesting to determine this accurately; but the heat being too high for measurement by the mercurial thermometer, and having no other, I have only been able to judge approximately by comparative tests. Melted under similar conditions with other metals, I find the metal requires for its fusion nearly the same heat as lead. It is somewhat later in melting, but, on the other hand, it appears to congeal a little the sooner, which may be due to a difference in the conducting power of the two metals. I should, therefore, place its melting point, in round numbers, at 600° F., that of lead being placed by different authors at 594°, 600°, and 612°. It volatilises at a somewhat higher temperature, giving off orange-coloured, suffocating fumes, which, when inhaled too freely, leave a disagreeable, sweetish, styptic sensation upon the lips, and an intolerable and persistent brassy taste in the mouth and fauces, with constriction of the throat, heaviness in the head, and nausea.

Of the general properties of cadmium as an ingredient in alloys, Overman, who I believe is a high authority in metallurgy, and who, although too broad in some of his conclusions, is more rigidly exact in respect to the individual instances adduced than others that I have had the opportunity of examining, says:—

"Cadmium is very soft and malleable, and still all its alloys are brittle. Its combinations are not distinguished for fluidity." Again:— "The combinations of platinum, copper, and other metals with cadmium are brittle and hard." The cause of this he ascribes to "its volatile nature and want of affinity," which, recurring to the subject, he accounts for thus:—

"When it is melted with any other metal there is a tendency on its part to evaporate. The slight affinity of cadmium for other metals causes a separation of its atoms from those of the other metal, and no intimate union can be formed. If, therefore, the alloy cools, there are spaces between the crystals which have been occupied by the expanded atoms of cadmium, and in cooling these are filled again; this causes brittleness." "Treatise on Metallurgy," p. 465.

All this is strictly true of some of its combinations, such as the particular instances which he cites, although by no means of "all," as will presently be seen.

Other authors, although less explicit, are to a like import, ascribing a similar general character to the metal, with examples in illustration, and without instancing any exceptions.

In a copy of an article on "Alloys of Cadmium," from Berthier's "Traité des Essais," tome ii. p. 530, furnished me by the Patent Office as authority on the subject, I find it stated in general terms that "most of the alloys of cadmium are brittle." The individual alloys cited are particularly characterized as brittle, and no mention is made of others. The combination with mercury is thus described:—"Cadmium unites with great facility with mercury, even when cold. The amalgam is of a silver white, and texture granular and crystalline. It can be obtained in octohedrons. It is hard and very fragile. Its density is greater than that of mercury. It fuses at 75° C. It contains 0·217 of cadmium."

Combined in these proportions, the compound will, indeed, be comparatively fragile; but one might be led to infer from this description that the metals combine in no other proportions. I have seen this particular form of amalgam cited by other authors when speaking of the combination of cadmium with mercury, but without any allusion

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to other compounds of these metals, although they unite with facility in other proportions, forming amalgams particularly noteworthy as contrasted with those of other metals.

While it has been assumed as a general rule, as above quoted, that the combinations of cadmium are not distinguished for fluidity, I have not found its fluidifying properties in respect to certain metals and alloys noticed in any work to which I have had access. Some of its alloys, indeed, are not remarkable for fusibility, but rather for the reverse; such are its alloys with silver, antimony, and mercury, their melting point being but little lower, or even higher, than that of the mean of their constituents. But others are much more fusible than the mean, as its alloys with lead, tin, copper, bismuth, zinc. In certain instances it manifests this property in so eminent a degree, that it is singular it should not, if known, have been explicitly stated in all professed descriptions of the metal. Bismuth holds a high rank among metals for its property of promoting fusibility in alloys, as is particularly remarked in all chemical text-books, and wherever the metal is treated of, its alloys with lead and tin being specially noted as extraordinary instances. But in some combinations cadmium displays this property more decidedly than even bismuth. The alloy composed of from one to two parts of cadmium, two parts of lead, and four parts of tin, is more fusible than the corresponding alloy of two parts (or less) of bismuth, two of lead, and four of tin. In smaller proportions its superiority is still more marked, requiring much less to produce the same effect, while it does not impair the tenacity and malleability of the alloys, but confers hardness and general strength.

As to the brittleness which cadmium is said to communicate when combined with any other metals, the facts are, some of its alloys, even with malleable metals, are "brittle." But others are highly tenacious and malleable. Its alloys with gold, platinum, and copper, afford instances of the former. Its combinations with lead, tin, and, to a certain extent, with silver and mercury, are examples of the latter. An alloy of two parts silver and one of cadmium is perfectly malleable, and very hard and strong. With equal parts of each it is also malleable, but possesses less tenacity; but when mixed in the proportions of two parts of cadmium and one part of silver, it is brittle. Equal parts of cadmium and mercury form a tough and highly malleable composition; in the proportions of two parts of the latter to one of the former, the amalgam is nearly equal in malleability, but possesses less strength. These mixtures are remarkable in view of the fact that most amalgams are exceedingly frail and brittle. A mixture of two or three parts of tin with one part of mercury, is so fragile as almost to drop to pieces in handling. The amalgams with lead, bismuth, &c., are similar.

The fusibility of the compounds of cadmium and mercury is nearly that of the mean of their constituents, as, indeed, appears to be the case with other amalgams. I do not perceive that mercury acts as a fluidifying agent in alloys. It does not strictly promote fusibility, but serves merely to communicate of its own fluidity to the compounds in nearly the ratio in which it is employed; it does not, like cadmium, bismuth, &c., confer any new property in this respect. Being fluid at 39° below the zero of Fahrenheit's scale, it will of course, if it only retains its own property, reduce the melting point of the compounds into which it enters as an ingredient below that of the metals with which it is united.

Most of the mixtures of mercury with other metals, although it may form certain definite compounds with them, indicate combination by simple solution and mechanical admixture rather than by chemical affinity. With cadmium, however, it exhibits a marked affinity for forming amalgams, or, as they might be appropriately designated, alloys which possess distinctive characters, indicating a true chemical combination.

But I leave these speculations to professed chemists, hoping the points herein referred to may serve to incite attention to a subject which, I think, will repay investigation.—*Journ. Franklin Institute.*

The Student.

We recommend the attention of the electrical student to the instructive problem referred to in our first article this week, in which are involved several of the principles we have lately considered. It is mainly by the experimental application of theory to practice in similar cases, that we can obtain a knowledge of the relations of cause and effect in the phenomena of dynamic electricity. We propose now simply to state some of the principal facts discovered by the genius of Ampère, and employed by him as the basis of his general theory explanatory of these phenomena. These facts, already established by experiments, can thus be illustrated or applied by those whose ingenuity may lead them to the construction of new apparatus or instruments. It is to be observed, that the theory of Ampère clearly establishes the connection between the reactions of voltaic currents upon each other and upon magnets, the action of the latter upon currents, and the various phenomena of magnetism.

First Proposition.—Two moveable parallel conductors conveying a voltaic current, are attracted when the current traverses both in the same direction, and are repelled when the current passes in opposite directions.

Second Proposition.—The force of attraction and repulsion in a wire bent into the form of a coil or helix is, *ceteris paribus*, the same as in a straight wire, providing the action takes place at a certain distance, dependent upon the diameter of the coils of wire.

Third Proposition.—In two conductors crossing each other, but not in electrical contact, those portions in which the current is proceeding in the same direction to or from the point of crossing, are attracted, those portions in which the current proceeds in opposite directions are repelled.

Fourth Proposition.—Two portions of a conductor traversed by the same current mutually repel each other.

From these fundamental propositions may be deduced all the reactions of "fixed currents" upon "moveable currents."

To represent these conditions in practice, a number of ingenious, but in some cases complicated, apparatus have been devised. Several of these we shall have occasion to describe. The moveable conductor is often brought into contact with water or mercury, through which the current is transmitted; in other contrivances two portions of wire are bent somewhat into the form of a parallelogram, one of these being fixed to an upright of metal carrying at its upper extremity a cup containing mercury, and the other being poised upon a pivot dipping into the cup.

Recent Patents.

458. Lord A. S. CHURCHILL, *Rutland Gate, Hyde Park, London*, "*Electric Telegraphs.*"—*Dated 20th February*, 1862.

In carrying out this invention the inventor employs two wires to produce a single sign on the indicating instrument, one to carry the outgoing, and the other the incoming current. These wires are caused to take different routes, so that the distance between the outgoing and incoming wire may be considerable, and the wires are uninsulated, by which he means that contacts between each wire and the earth, or places where the current may pass from the wire to the earth, are so numerous or extensive as to render the wire unsuitable for telegraphing in the usual manner, where the return of the current takes place through the earth.—*Not proceeded with.*

468. S. SMITH, *High Holborn, London*, "*Electro-magnetic Engines.*"—*Dated 21st February*, 1862.

This invention consists in a novel mode of arranging, disposing, mounting, and working soft iron cores or magnets, and other moving parts of electro-magnetic engines, so that, while each piece of soft iron shall be attracted or drawn towards and through the hollow central passage way or chamber of a helical magnetic coil, or series of such helical magnetic coils in turn, a direct action in a straight line through such coils is converted into a continuous rotary motion when the helices are connected with the battery, and a current of electricity is caused to circulate through the properly insulated wires forming the coils, and the action may be regulated by any of the well known means for making and breaking contact. Instead of arranging the magnets around the circumference of a revolving frame or disc, or in any of the ordinary modes or methods heretofore employed, the inventor forms a jointed belt or chain, or a series of pieces of any suitable shape, connected or hinged together so as to form an endless band or belt, composed of alternate conducting and non-conducting material or materials subject to the action of electro-magnetism, alternated with those not subject to such influence while passing through the helices, and he mounts or supports such a chain or series of materials so disposed upon two drums, or the peripheries of suitably mounted wheels, or their equivalents, and these drums are caused to rotate by the alternate attraction of the iron links or portions of the chain, motion being communicated from one or both of these drums by means of toothed gearing, or in any other convenient manner.—*Not proceeded with.*

DR. RENNIE, of the 81st Foot, now in China, has published a report on the subject of small-pox, in which he states that the treatment adopted by him, viz.:—the application of an ointment of tartar emetic or croton oil, or the two combined, produces an effect of a "galvanic or electric" character. He also states his belief that further research may lead to the use of electricity direct for the cure of a numerous class of diseases. The report, which contains a statement of several cases, has been forwarded from China to the Commander-in-Chief.

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Fine ... ... 2s. 4d. to 2s. 6d. per lb.
Genuine ... ... 1s. 5d. to 1s. 10d. „
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Both markets very dull.

September 17, 1862. Wm. Kirkmann,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic, A.	100	50 to 54	———
20	Do. B 7 per cent. till 1862 .	all	19 to 21	———
20	Do. C	all	———	———
Stock	Electric Telegraph . .	100	100 to 103	———
25	Do. New	20	———	———
5	London District Telegraph .	4¾	4¼ to 3¾ dis.	———
10	Mediterranean Extension Tel.	all	3½ to 4½	———
10	Do. 8 per cent. pref. . .	all	———	———
20	Red Sea and India Telegraph	all	———	———
1	Submarine Telegraph, scrip.	all	⅜ to ⅝	———
1	Do. registered . . .	all	⅜ to ⅝	———
10	Do. „ . . .	all	4 to 6	———
2	Telegraph to India . .	1	⅝ to ⅜ dis.	———
5	United Kingdom Telegraph .	8	½ dis. to par.	———

TELEGRAPHY.

From time to time protests have appeared in this journal against the meaningless and detrimental secrecy which has too long characterized the operations of telegraphy. To most of our readers it is well known that the history of the Malta and Alexandria Cable, which now yields a revenue of some £1,000 a week to its very fortunate contractors, has been, from the first day of its submersion, a profound mystery. An attempt has been made to conceal from the public the state of this cable, the amount of revenue derived therefrom, the scientific knowledge, and many other numerous advantages which are placed at the disposal of the "fortunate contractors," are inscribed in a "sealed book." Let an intelligent correspondent tell the tale. "I certainly think it desirable that the papers referring to the contract for making the Alexandria and Malta Cable should be made public, and the reason (if any) given why the working was not given to the Company on the spot, viz., the Meterranean Extension Telegraph Company, then the public would have been furnished with the details of its working expenses, receipts, &c." Our correspondent further adds, "the receipts for the last six months have been at the rate of £1,000 per week." Can any of our readers arrive at any other conclusion than that arrived at by our correspondent, when he states, and the truthfulness of his statement is apparent, that "the great fault hitherto has been that one or two large contractors have had a monopoly, and the public have been sacrificed in consequence." This is true: an incontrovertible fact. Our correspondent further adds, "manufacturing and submerging cables are, and should be, totally distinct branches from working them when laid down. Every detail of the working of telegraphic cables is required to guide us to the entering into new undertakings; and it is not probable we can get this from a private firm."

The Government awarded a large sum of money for experimental purposes; a commission, consisting of the most illustrious engineers and electricians of the day, was formed, they toiled, they experimented, but to what purpose, to place a text-book in the hands of a monopoly, a monopoly which has, it is true, partially succeeded in shallow water, a feat which certainly presented no great difficulty, especially when we consider the vast quantity of iron wire employed, and herein lies the secret. Cables, whether intended for shallow or deep sea, must be enveloped in a *sheathing of iron wire.* The timely caution given by experienced telegraphic engineers as to the inevitable results which must occur from the sheathing of cables with naked iron wires, was ignored:—passed by unheeded. Expensive machinery had been constructed, coils upon coils of iron wire had been drawn, and the only market for their disposal was that of submarine telegraphy. The history of deep sea telegraphy has yet to be written. It has only its parallel in the history of the first few years of the struggles of our railway system.

PROFESSOR HUGHES' PRINTING INSTRUMENT.

We had an opportunity afforded us recently of witnessing, in practical operation, the above exceedingly ingenious and highly efficient instrument. It is being now employed in the transmission of messages between London and Liverpool, by the United Kingdom Telegraph Company. Our readers have already been made familiar with the nature and construction of the instrument, from a description and drawing thereof, which has appeared in The Electrician. The letters are printed with unerring rapidity, and with ease at the rate of forty words per minute. This has been effected through a distance of 700 miles.

Professor Hughes has completed arrangements for the disposal of his patent rights to the French and Italian Governments, and we are glad to find that so valuable an invention is about to be adopted in this country.

We append a specimen of the letter-imprint of the instrument.

THIS SPECIMEN OF PRINTING BY THE HUGHES PRINTING TELEGRAPH WAS SENT THROUGH SEVEN HUNDRED MILES OF WIRE. SEPT. 15, 1862.
SPECIMEN OF PRINTING BY THE HUGHES PRINTING TELEGRAPH PRESENTED TO THE EDITORS OF THE ELECTRICIAN WITH THE COMPLIMENTS OF THE INVENTOR. SEPT. 17, 1862.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The arrangements for the forthcoming meeting of this association at Cambridge are now approaching completion. The following is a programme of all that can at present be decided upon. The meeting (the thirty-second) will commence on Wednesday, October. 1. President, the Rev. Robert Willis, M.A., F.R.S., Jacksonian Professor of Natural and Experimental Philosophy, Cambridge. Vice-presidents, the Very Rev. the Dean of Ely, D.D.; the Rev W. Wewel, D.D., F.R.S., Master of Trinity College, Cambridge; the Rev. A. Sedgwick, M.A., F.R.S., Woodwardian Professor of Geology; G. B. Airy, Esq. M.A., F.R.S., Astronomer Royal; G. G. Stokes, Esq., M.A., F.R.S., Lucasian Professor of Mathematics; J. C. Adams, Esq., M.A., F.R.S., Lowndeian Professor of Astronomy and Geometry, and President of the Cambridge Philosophical Society. General Secretary, W. Hopkins, Esq., M.A., F.R.S., St. Peter's College, Cambridge. Assistant General Secretary, John Philips Esq., M.A., L.L.D., F.R.S., Professor of Geology, Oxford. Local secretaries; C. C. Babbington, Esq., M.A., F.R.S., Professor of Botany, Cambridge; G. D. Liveing, Esq., Professor of Chemistry, Cambridge; Rev. N. M. Ferrars, M.A., Gonville and Caius College, Cambridge. Local treasurer: Rev. W. M. Campion, B.D., Tutor of Queen's College, Cambridge. The Town Hall, which has been placed at the disposal of the association by the corporation, will be open as a reception room on Monday, Sept. 29, at ten a.m., and on the following days at eight a.m., for the issue of tickets to members, associates, and ladies, and supplying general information as to lodgings, &c., to strangers on their arrival. Persons desirous of becoming members or associates are to make application in this room. The "journal." containing announcements of the arrangements for each day, will be laid on the table on Wednesday, Oct. 1, and the following mornings, at eight a.m., for gratuitous distribution. The member's ticket contains a map of Cambridge, and particulars as to rooms appointed for sectional meetings. A branch post-office will be opened here, which will also be available for communication between members attending the meeting, and there is a telegraph-office in the same building.

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The general committee will hold its first meeting in the Town Hall, on Wednesday, Oct. 1, at one p.m., for the election of sectional officers, and the despatch of business usually brought before that body; and again, in the same room, on Monday, Oct. 6, at three p.m., for the purpose of deciding on the place of meeting in 1863; and the concluding meeting on Wednesday, Oct. 8, at one p.m., when the report of the committee of recommendations will be received. The first general meeting will be held in the Town Hall on Wednesday, Oct. 1, at eight p.m., when William Fairbairn, Esq., L.L.D., F.R.S., will resign the chair, and Professor Willis will assume the presidency, and deliver an address. The various sections will assemble in the rooms appointed for them, for the reading and discussion of reports and other communications, on Thursday, Friday, Saturday, Monday, and Tuesday, Oct. 2 to 7, at eleven a.m.

ON THE HEAT WHICH IS DEVELOPED AT THE POLES OF A VOLTAIC BATTERY DURING THE PASSAGE OF LUMINOUS DISCHARGES IN AIR AND IN VACUO.

BY JOHN P. GASSIOT, F.R.S.

1. WHEN the wires attached to the terminal plates of an extended series of a voltaic battery are brought into contact with each other, the circuit of the battery is completed; and if in this state the ends of the wires are separated from each other, the usual luminous or arc-discharge is produced, the length of the arc depending on the number of cells of which the battery consists. If this luminous discharge is continued for a few seconds, the metallic positive pole or anode becomes red-hot, and will ultimately be fused, while the negative remains comparatively cool. This experiment was originally described by me in the *Philosophical Magazine* of December 1838, p. 436. In the same periodical of June 1840, p. 478, Mr. Grove suggested, as an explanation, that this effect might be due to the interposed medium, and that, were there any analogy between the state assumed by voltaic electrodes in elastic media and that which they assumed in electrolytes, it would follow that the chemical action in the positive electrode in atmospheric air would be more violent than at the negative, and that if the chemical action were more violent, the heat would necessarily be more intense."

2. Since that time I am not aware that any other explanation relative to the heating of the positive pole of the voltaic battery has been published. Mr. Grove merely gives it as a suggestion; but as it is immaterial whether either or both poles are of copper, aluminium, platinum, or any other metal, or of coke, as in either case it is the positive that is heated, the phenomenon cannot arise from any effect of oxidation, but must be due to some action in the battery circuit hitherto unexplained.

3. In the Bakerian Lecture for 1858, I have stated that, "when the discharge from an induction coil is taken in air or in vacuo with thin platinum wires, the negative terminal becomes red-hot, and if the discharges are continued the wire will be fused." This heating of the negative terminal, provided the wires are thin, always takes place whatever may be the length of the discharge or the medium through which it passes.

4. That this heating of the negative terminal in the discharge from an induction coil had some intimate relation to the heating of the positive pole of the voltaic battery was very probable; but why in the one case the heat should be evolved at the negative, and in the other at the positive terminal, appeared extraordinary and well worth further investigation. The result of the experiments I have made with this object forms the subject of the present communication.

5. After verifying the fact that the heating of the negative terminal of an induction coil is always obtained either in a carbonic acid vacuum, in rarefied gases, or in air, provided the terminal wire is thin, but not if thick, I proceeded to examine with greater precision than formerly the nature and character of the luminous discharges in vacuo, as obtained from my water-battery, as well as from the 400 insulated cells of the nitric acid battery (*Phil. Mag.* S. 4, vol. xx. p. 540); and for this object I had several small vacuum tubes constructed, about 3 inches long and 1 inch diameter; in each of these, two metallic or carbon balls, about ⅛ of an inch in diameter, were attached to the platinum wires, hermetically sealed in the tube about 1 inch apart. Each wire is protected by a glass tube as far as the ball; the vacuum is obtained by means of carbonic acid, absorbed by caustic potassa, as described in my former communications.

6. The discharges in these tubes from an induction coil, or from my water-battery present nearly the same appearance, viz., a brilliant luminosity surrounding the negative ball, generally without, but sometimes with a minute stratified discharge from the positive.

7. When the vacuum tube is introduced into the circuit of 400 insulated cells of the nitric acid battery, the discharge at first always assumes the form first mentioned. This discharge, as well as those from the induction coil and the water battery, when examined, is found to be very perceptibly intermittent, and will generally continue for some time after the circuit has been completed. As the action of the battery improves, *the luminous glow round the negative metallic ball gradually increases in size*, and in a few seconds the ball becomes red-hot. This result I repeatedly obtained; and in two instances with tubes, in which balls of aluminium, ½ inch diameter, had been inserted, the negative dropped from the wire into the tube in a molten state, but leaving the positive ball with its original metallic lustre.

8. The preceding experiments, so far from assisting me in explaining the cause of the heating of the positive pole of the voltaic battery, rather tended to complicate the inquiry; for experiment now showed that in carbonic acid vacua the heating effect was elicited at the negative pole, whether the discharge was made from a voltaic battery or from an induction coil; but as experiment also showed that heat is always evolved from the latter at the negative, whether in air or in vacuo, and that from the battery it always in air appears at the positive, it was evident the media through which discharges were made afforded no explanation for the elucidation of a phenomenon of which hitherto the more it was examined by experiment the more difficult appeared the solution.

9. My next experiments were made in vacuum tubes in which balls of carbon were inserted in lieu of metal. With these I at first obtained the usual heating of the negative; but in one instance I observed that both balls were at the same time exhibiting red heat; in this instance, either from some alteration having taken place in the vacuum, or from some other cause which I had not time to examine, the discharge from the carbon balls became so uncertain as to afford me little information worth recording, except as to the fact I have stated of both balls being heated: the cause of this I was subsequently enabled to determine.

10. In two of the vacuum tubes hollow brass balls had been attached to the platinum wires. In the first of these the negative very soon became heated by the discharge. As the discharge of the battery continued, a sudden flash of light was visible in the vacuum, and the glass instantly became coated with metal. On examining the tube, I ascertained that one-half of the negative ball was separated from the other, and partly fused: the intense heat had vaporized the silver with which the two hemispheres forming the ball had been soldered, and it was this vaporized metal that was deposited on the sides of the tube. The positive ball remained much tarnished, as if it had also been heated.

11. I then introduced the second tube, having similar hollow brass balls, into the circuit of the battery. In this tube the negative also was at first heated to redness; when in this state, a sudden brilliant stratified discharge took place.

The evolution of nitrous acid fumes in the battery denoted its intense action. This discharge from the battery continued for about two seconds, *the negative ball instantly losing its luminosity, the positive becoming red-hot*.

12. This experiment appeared to offer an explanation as to the cause of the heating of the poles; but on attempting to repeat it, the tube was unfortunately fractured by the heating of the platinum wire, as were also two tubes with coke balls: the result I had obtained was, however, too interesting to me not to repeat the experiment; and I had six vacuum tubes prepared, each of the same dimensions as already described, two with coke balls, two with iron, and two with copper, all solid: the best and most conclusive results were obtained with the copper. The experiments which I now proceed to describe were made on the 27th of last May, in the presence of the Rev. Dr. Robinson and Professor Stokes.

13. In the first tube the negative ball very soon became red-hot, when suddenly the brilliant, clearly defined, conical stratified discharge appeared, continuing for three or four seconds. On breaking the circuit of the battery, we ascertained that the negative ball, or that attached to the zinc terminal of the battery, had, as before, entirely lost its heated appearance, while the positive, or that attached to the platinum end of the battery, remained at a dull red heat, which it retained for two or three seconds after the circuit of the battery had been broken.

14. A second tube with copper balls was then introduced into the battery circuit; in this I also obtained the usual luminous negative glow discharge surrounding the ball attached to the zinc terminal of the battery; this glow, as before, gradually enlarged, and in a few seconds the ball became red-hot; the circuit of the battery was then instantly broken, the negative ball retaining its red heat for several

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seconds. In this experiment it will be observed that the circuit of the battery was broken before the sudden brilliant discharge, previously described, had appeared. These results fully confirmed my original experiment (11) of the alternate heating of the positive and negative terminals of the voltaic battery, when the discharge is made in vacuo.

15. The result of my previous experiment (11) having been thus confirmed, the explanation of those that preceded it became easy of solution. When both coke terminals (9) were heated to redness, the continuous or arc discharge had only lasted for an instant, evolving heat at the positive terminal; but the negative during this short interval retained the luminosity it had previously acquired, and consequently at the time of the disruption of the circuit, both coke terminal balls exhibited red heat. Again, in the first experiment with the brass balls (10), the arc discharge was also only momentary, a disruption of the circuit having been caused by the partial fusion of the negative ball; but the duration of this discharge was sufficient to tarnish the positive terminal; while with balls of aluminium (7), a metal that fuses at a very low temperature, the negative was melted by the heat evolved in the intermittent discharge; and we ascertain that under this condition the positive terminal is in no way affected, for the metal retained its original lustre.

16. The voltaic discharge of a battery of 400 insulated cells, charged with nitric and sulphuric acid, when observed in these vacuum-tubes, at first assumes precisely the same appearance as that of one of nearly 4000 cells charged with rain-water, as it is also similar to that of the discharge from an induction coil; but the action of the nitric acid so far differs from that of the water-battery, that while the discharge of the latter will remain for several weeks (or until the water in some of the cells has evaporated) of nearly the same form and appearance, the discharge from the nitric-acid battery quickly alters: as the action of the battery improves, the glow round the negative terminal enlarges, heat in that portion of the tube is sensibly developed, as can be ascertained by touching the tube with the hand, and in a few seconds the negative ball becomes red-hot. During this time no apparent sign of chemical action takes place in the cells of the battery; the heating effect appears to be mainly due to the elevation of tension; for if the copper wires attached to the terminals rest on gold-leaf electroscopes, the leaves continue expanded until the arc discharge takes place, when they instantly collapse, and heat is evolved at the positive terminal.

17. In vacuo, as long as the intermittent discharge continues, resistance apparently takes place at the negative terminal; and this is not only evinced by the heat which is evolved, but by the disruption of the metal, which is separated from this pole in minute particles, and deposited in a lateral direction on the sides of the vacuum tube.

18. As soon as the action of the battery becomes sufficiently energetic, so as to cause the continuous or arc discharge to pass, an entirely new effect is developed: the discharge itself becomes intensely vivid, the stratifications assume a conical form with their apex directed towards the negative, and heat is instantly perceptible at the positive terminal, while the negative as instantly cools.

19. It is beautiful and interesting to observe the suddenness with which the red heat of the negative terminal ball disappears, and the equal suddenness with which the heat is at the same instant elicited in the positive, when the brilliant arc discharge takes place.

From the results obtained by these experiments, I infer that the development of heat, either at the positive or the negative pole of a voltaic battery, is entirely due to the amount of resistance which takes takes place in that part of the battery circuit.—Philosophical Magazine.

Law Intelligence.

WHEATSTONE AND THE UNIVERSAL TELEGRAPH COMPANY v. WILDE.

THIS important patent case, which was partly heard before Mr. Baron Wilde and a special jury, and afterwards referred for arbitration to Mr. Lush, Q.C., after a protracted hearing of twelve days, has at length terminated in favour of the defendant.

The plaintiff's invention, upon which the action was brought, was for an improvement in the transmitting instrument of a magneto-electric dial telegraph, which consisted in a method of keeping the armature of the magneto-electric machine in continuous motion, while finger-keys regulated the passage of the currents in the telegraphic circuit.

The defendant, by the peculiar construction of his magneto-electric machine, was enabled to stop the armature every time a finger-key was depressed. The armature was made to revolve by means of a pulley driven by a band, the tension of which was so regulated that when the mechanism of the transmitting instrument (including the armature) was stopped by the depression of a finger-key, the band slipped upon the pulley and no more currents were produced; but on releasing the finger-key the motion was immediately taken up, and currents were again generated and allowed to pass into the circuit.

The plaintiffs contended that continuous motion of the motive power was equivalent to a continuous motion of the armature.

It was, however, clearly shown that this was not so, for the defendant's armature required to be made very light, so that it might be stopped with facility, while, on the other hand, the plaintiffs' armature, being kept in continuous motion, its size and weight were of no consequence.

The arbitrator, therefore, decided that a stopping armature could be no infringement of an armature in continuous motion, and that the bill of complaint in the Court of Chancery should be dismissed, and the costs thereof, and of the reference and award should be paid by the plaintiffs.

Telegraphic News.

THE road between Lahore and Mooltan is impassable, being inundated by the overflowing of the rivers, and the unprecedented quantity of rain that has fallen. The telegraphic communication between the two places has been stopped in consequence of the fall of the posts from the effects of the inundation.

The Governor General in Council has given the following instructions to the Electric Telegraph Department in respect of the transmission of telegrams for the Chambers of Commerce and the public press:—

"Messages for the Chambers of Commerce to be treated as if they were Government messages, and to have precedence of *all* others, on the same conditions as at present, so long as they are purely commercial. All press messages received from Europe, if sent as received and without alteration, to have priority over all other messages, and to be entitled to the privilege of clearing the line without reference to the channel through which they are received at the Telegraph Office, but to have priority there *over each other* in the order of their receipt, and over private European messages, as well as over locally prepared messages, even though containing European news."

TELEGRAPHIC COMMUNICATION WITH PEKIN.

THE telegraphic communication, now in course of construction by M. Reuter through Russia, Siberia, and Mongolia, to connect Pekin with St. Petersburg and London, is expected to be completed in six months.—*London and China Telegraph.*

SUBMARINE CABLE IN THE LAKE OF CONSTANCE.

THE cable intended to establish a direct telegraphic communication between Bavaria and Switzerland was lately submerged. The total length is 70,000 feet, and its weight 280 quintals. According to the soundings which have been made, the greatest depth in the Lake of Constance where the cable will be placed, is 300 feet.—*Augsburg Gazette.*

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

RAILWAY TELEGRAPHS.

To the Editor of THE ELECTRICIAN.

SIR,—In the portion of the above article, appearing in No. 48, August 29, Mr. Preece mentions a train signalling instrument, which I have introduced, but as he has only partially described it, and mentioned it in a manner certainly that does not recommend it, may I ask the favour, in justice to my introduction, of your inserting the following description of it:—

The instrument is about the same size as the ordinary single needle instrument generally in use. It has an entirely plain light green dial, with an oblong slit or hole in it; behind this dial swings a balanced needle, to the top of this needle is fixed two discs, one on either side, one disc is red with white letters on it in bold type, TRAIN ON LINE, the other disc is white with black letters in large type, LINE CLEAR. The red represents the danger signal; the white, the all right signal, and thus the telegraph signals are assimilated to those on the line, for regulating the trains. Below the dial are two keys, one red, labelled "Train on Line," the other white, labelled "Line Clear" to correspond with the discs, so that to give either of these two signals, is simply done by pegging down the key labelled in accordance with the signal required to be given, which will have the effect of bringing up the same signal in the slit or hole in the dial on the instrument from which the signal is sent, and also on the one at the other end to which the communication is made; whatever appears on one instrument must appear on the other. There is no mechanism of any kind used in the construction of this instrument. It simply consists of a spring key to send the current from the battery to the needle to which the discs are fixed, nor can it be deranged or broken, unless violence is used. This instrument can be worked on the permanent block system, or by giving

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the signals, and entering the same in a book; the former plan is the best. The instrument is intended only for working single lines and tunnels, but can be used on main lines where trains follow each other in rapid succession, to great advantage, if they are placed at such a distance apart that a train can run the length between each signalman within the interval of time allowed before one train is permitted to follow another. Should a wire break while either key is down, the needle falls vertically, and then registers immediately at each end a fault.

When the needle is in this position it shows half of each disc (half red and half white) in the hole in the dial. It also registers the gradual failure, or exhaustion, of the battery, which is most essential, and indicates it thus:—When the key is pressed or pegged down the disc, instead of entirely filling the slit or hole in the dial, a small corner of the other disc is just visible, and as the exhaustion increases so the portion of the other disc becomes more visible, although the signal intended to be given is unmistakable. Mr. Preece states this instrument is liable to reversal by lighting. In tunnels, where wires are covered and placed in a wooden casing, no lightning can possibly affect it; on open single lines a covered or painted wire, which is very inexpensive, can be used, and by this means will also be safe. But if the permanent block system is worked no mistake can arise, if covered or painted wires are not used, as it is clearly known that a man to whom a train is approaching always pegs down or returns the same signal, viz., Train on Line (the red disc), and after, he returns "Line Clear" to the man who signalled the train to him when it arrives at his station, he (the man from whom the train proceeded) pegs down the line clear signal (the white disc) registering the signal returned, showing the train's safe arrival at the other end, and that the line is clear for another to follow without having to stop it to obtain "Line Clear;" so that if lightning does reverse the poles of the needle the wrong signal would be shown, and the men would immediately know the cause. Any instrument fixed to uncovered open wires is liable to be affected by atmospheric electricity. A bell is used in conjunction with this instrument, a shrill-toned one for up trains, a deep-toned one for down trains. The trouble and loss of time in teaching men cypher codes or cypher alphabets is entirely overcome, all who have seen it can at once comprehend it. Another great advantage is that only one signal, and the one intended is shown, by having the disc entirely clear. Superintendents or any any one else going into the signal hut can see for himself what signal is on or what is passing. An instrument is fixed in the Telegraph Office, at Paddington, which can be seen by any one desirous of viewing it. In conclusion, I may perhaps be permitted to say that on the Great Western a man is not appointed unless he can read and write, and when approved, no newly-appointed man is placed to such duties as signal, switch, or pointsman, these places are only given to tried men, the recruits undergo their drill as ordinary policemen and door keepers, under a serjeant, until fitted for more important duties.—I am, sir, yours, &c., C. E. Spagnioletti.

To the Editor of The Electrician.

Sir,—Will you please inform me where I can obtain the "published specification" of Mr. Preece's instrument referred to in the paper on Railway Telegraphs, page 196, also the number of wires required to work the system; according to the description given in The Electrician there is only three, and, if so, I should like to know how the instruments would act if A and B were both to make use of the instruments at the same time, would it not cause confusion in the signals? The plan certainly appears to me an excellent one; but I think it would have been better understood had it been more fully described.—I am, sir, yours, &c.,

Manchester, September 15th, 1862. B. C.

TEXTS FROM THE BLUE BOOK—No. V.

"The manner in which gutta percha can be manipulated and placed on the wire by being forced through a disc, renders it less liable to flaws when laid over the wire than india rubber."—*Government Report*, page 34.

To the Editor of The Electrician.

Sir,—There are a great many trite axioms afloat in the world of all descriptions, moral, religious, social, scientific, ethical, physical, and metaphysical which pass current among us as sterling coin. These we look upon and treat with a respect and veneration in proportion to their antiquity and the eminence of their origin; generally speaking, these and similar venerable considerations secure them immunity from the sacrilegious scalpel knife of the quibbler and critic, and so pass down from age to age unquestioned and incrusted with the credulous respect of remote generations. Hence, in some instances, this incrustation of implicit faith becomes so formidable, from its immemoriability, as to render it a work of extreme difficulty to remove, which work, by the bye, is esteemed in the highest degree audacious, if not as sacrilegious as was the demolishing of the Temple of Apollo to the admiring worshippers of that Beau Brummel of a God.

But we are wonderfully daring and intrepid in these modern times; and so much has it become the custom to call everything into question, that some clever people, for lack of something better to do, will even attack self-evident propositions which cannot be overturned, and yet they will knock them over, apparently, as nicely as possible. What has the moon to do with the tides? or the sun with the solar system? so called; and as to the jackal pioneering the lion to his prey, who believes it? and Richard with his spine all awry, was *not* a fiend incarnate, but a very amiable, humane, and courteous gentleman. Nay, to such an extent is this quibbling, for the sake of quibbling carried, that a friend of mine assures me "that if equals be added to equals the sums will *not* be equal."

Well now our text, if it be allowed to go unquestioned, will doubtless pass current among us as a fact, and yet I hope to prove that it is not a fact, but just the reverse; originating, doubtless, from a want of a practical knowledge of the subject. I am very desirous of avoiding all connection with the class of quibblers above mentioned, for if a question be fraught with any doubt, I would rather the good people who believe therein should enjoy their belief undisturbed, if it were out of my power to prove it a fallacy; and I see no good in pulling to pieces, on even a Carlylian system, unless you can build up again and improve the edifice. But still the demolisher of even absurd and fallacious notions is looked upon as a terrible invader by some people, and ought to be put down. And some people will doubtless think so of me when I deny the truth of the assertion contained in the text.

At first sight, the easy manipulation of gutta percha, owing to the facility with which it may be reduced to a pulp by subjecting it to a moderate heat, would appear to favour the idea contained in the text; and when it is further considered that the same process will not produce the same effect on india rubber, and, therefore, necessitates recourse to some other expedient in order to compass the same ends, the apparently feasible grounds upon which the statement rests seems thereby to receive further confirmation. India rubber cannot be reduced to a pulpy state and then applied to the wire while in that condition, and so the conclusion is arrived at (logically or illogically, I daresay, according to the individual leaning of your readers to this or that material) that, therefore, it must be liable to flaws on that account. To me it seems as logical as the argument used by the old lady against travelling in a steamer. "You know in these new fangled vessels—drat 'em—my dear, the boiler may burst and blow you beyond the influence of gravitation, which cannot be the case if you go in a ship that has no boiler to burst."

As regards gutta percha it *must* be applied by a die process, while in a semi-decomposed state, or not at all; in its solid state, when cut, it has not that adhesive affinity, the one surface for the other, which fresh sliced india rubber has, neither can it be had in attenuated tapes, a condition it need not desire if our text be true. But if it be capable of application to the wire, only in a pulpy state and by a die process, what more can be desired, since we have the authority of the Committee of the Lords' Committee of the Privy Council that that is the condition an insulator should be in, in order effectually to accomplish the enveloping process without flaws.

Now we must bear in mind that at the time the Government Committee were pursuing their investigations, gutta percha insulation was an established fact; all the cables submerged, and in process of submersion, were of this description, hence there was ample data whereon to found any conclusions relative thereto, without having any recourse to theoretical speculation; and what were the facts elicited by this committee? one was that the method by which gutta percha was applied to the wire, had a tendency to cause air-holes; another that it did not, and could not ensure uniform centricity of the conductor. These two indisputable facts, which any one may see by referring to the pages of the Blue Book, will be amply sufficient for our present purpose. The question is, are these to be considered flaws? if not, there is an end of the matter, and the compilers of the Report save intact their consistency. But I maintain that they are flaws, and very serious ones too, which gutta percha cable manufacturers themselves do not attempt to deny. But on the contrary, evince a very commendable disposition to overcome them. It is urged, I know, that these flaws may be prevented by applying the percha in a series of thin coatings, so that if the previous coating should have air-cells formed therein the succeeding one would fill them up, and so on; also that this repetition of thin envelopes would prevent any divergence of the wire from the centre; to a certain extent this measure is doubtless preventive, but it is *only* to a certain extent, and at the time the statement was made, it was hazarded as a purely gratuitous conjecture. It is by no means certain that each successive layer would fill up the air-holes of its predecessor; and any one at all conversant with the subject may give a pretty near guess as to how far it will tend to centralize the conductor, when it is considered what a state of sticky plasticity the whole is in during the process, so that it could offer no obstacle to the slightest pressure from within, should any untoward influence cause the wire to diverge. Neither could the cleverest workman ensure that the thin coating of gutta percha should spread in one unbroken uniformity over the whole area of the wire, whether as regards the first or any succeeding coating. The fact is, immunity from these defects cannot be secured, they will always exist as *the flaws* peculiar to gutta percha insulation. And it is a tacit acknowledgment, on the part of the manufacturers of these wires, of the existence of such flaws, that they cry out so lustily against the use of Reid's pressure test, because it finds out these defects, and so injures the cable in the discovery; whereas they know if their cables were perfectly made, and such a thing as an air-cell did not exist in them, that the test above named would improve the condition of the cable rather than otherwise.

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So much for gutta percha insulation and the flaws peculiar to it; now for a few words with respect to india rubber, which, if the text be trustworthy, labours under the serious disadvantage of being very inferior to gutta percha in the flaws it entails in its application to the wire.

There is more than one way of applying india rubber for insulating purposes, but the method presupposed in the text doubtless alludes to the spiral layers of tapes generally adopted, and it is to this mode, therefore, that these remarks particularly refer. If it were necessary to remind you that gutta percha insulation was an established fact at the time the committee commenced their enquiries, it is no less necessary to state that the reverse was the case with respect to india rubber, and therefore, in contradistinction to the former, where absolute facts, and long experimental results, rendered theoretical assumptions unnecessary, all statements respecting the latter in its character as an insulator were necessarily conjectural, and based upon assumptions more or less theoretical; and so far as the *manufacture* of a caoutchouc insulated wire is concerned, it must have been pre-eminently so, since none at that time were in being, save a few, hastily put together for the government experiments. The assertion contained in the text, therefore, is apocryphal, which might not have been unjustifiable at the time, all things considered; but it becomes our duty, now that practical experience has been brought to bear upon the matter, to sift it thoroughly; and if it contain a fallacy, to explode the same as being unjustly prejudicial to the material in question, and liable to lead those astray who are anxious to be correctly informed upon a matter which is by no means unimportant.

It will be seen at once that air-cells cannot occur in caoutchouc insulated wires, it is equally impossible also for the conductor to become eccentric; what then is the nature of the flaws to which they are liable? it cannot be in the rubber tape itself, which we know to be comparatively impervious, even when stretched to extreme attenuation; the flaws must occur, therefore, if flaws there be, in the spiral wraps, where the edge of one wrap impinges upon the preceding one. Well, if defects occur in this way, it must either be one continuous defect from end to end of the wire, which is equivalent to saying that there is no efficient means of securing the adhesion of the layers, one to the other, than which nothing can well be more absurd; or the flaws must be caused by carelessness in the workman, who neglects the necessary means of securing uniformity in his wraps, and the means of uniting the same. This last is really the only way in which defects can occur. But then these are preventible, nay, more ought never to occur, and are by no means a necessary concomitant of india rubber insulation. I grant you that it is possible to produce flaws in india rubber insulation, by using deleterious solvents. But then the use of anything injurious to the gum is no more necessary in order to insulate efficiently, than it is necessary for me to nourish my internal man on opium, or any other noxious drug. We thus arrive at the end of our tether; the flaws to which india rubber insulation is liable, are preventible by merely ordinary care and precaution on the part of the workman, and therefore strictly speaking cannot be considered indigenous. It is possible to make any length of india rubber insulated wire totally free from flaws, if you see that all your materials are of the right sort, and the operator one that can be depended on. It is not so, however, as has already been shown, with regard to gutta percha. It is a moral impossibility to make any considerable length of such wires totally exempt from the flaws peculiar to it. Hence the text requires, in order to read correctly, a total reversion, and should read thus: "The manner in which india rubber can be manipulated and placed on the wire, by *not* being forced through a die, renders it less liable to flaws when laid over the wire than gutta percha."

Amicus.

To the Editor of The Electrician.

Sir,—Having glanced through your journal from the commencement, and having failed to obtain any information upon the subject of electrical science as applied to medical practice, I hope I shall not be deemed exigent if I call attention to the matter with the view of eliminating such truths as have already become partially recognized amongst physicians of acknowledged integrity and sound learning. Such apparently occult mysteries as the science of electricity presents to the uninitiated public may naturally excite feelings of distrust in the minds of nervous and excitable patients, and as no one will for a moment hesitate to believe that perfect confidence on the part of the invalid in the skill and discretion of his medical adviser, is the first and most powerful agent in carrying into effect the medicines prescribed, so it becomes essential to the cause of electric science as applied to the healing art, that nothing bearing the appearance of charlatanism should be allowed to obtrude itself in the columns of your valuable journal, but that all the startling facts which might be legitimately brought before the notice of your readers should bear the signature or indorsement of men of known capability and indisputable veracity. I make no doubt but that you have received many communications upon the subject which you have deemed unfit for your publication, but still I hope that you will not reject any that may come from unexceptionable sources, and as I am convinced that electricity is a powerful remedial agent, I trust that in the interest of humanity you will lend your aid to promote its application to such an important purpose.—I am, sir, yours &c.

September 17 1862. Philanthropos.

Miscellanea.

My First Sight of the Electric Telegraph.—Shall I ever forget it? Being informed that the infant Ariel was to be found deposited in a huge box, and carefully wrapped up in the softest of wadding, I entered the room in which the said box had been placed, and, as the sequel proves, with all that innocence of the "wonders of art" as might be expected of a "raw country lad." After cautiously removing the lid from the box, I found, as anticipated, its contents covered with a profusion of the material above described. Gently drawing aside the only obstruction, as I thought, that now remained between me and the object which was to gratify my curiosity, what did I behold? A mangled corpse! My confusion and horror can be more easily imagined than described: there lay the trunkless head, the countenance exhibiting all the lividness and ghastliness of death:—the powerless arm and the pulseless heart. I stood bewildered and aghast. * * * The following interesting quotation from Dr. Hamel's valuable work will explain the mysterious contents of that ever memorable box, in which I found ensconsed, the infant Ariel:—William Fothergill Cooke, who, as a young man, had been six years in India in military service, had, in 1831, come to England on leave to visit his parents, and had, soon after that, left the service altogether. His father Dr. William Cooke (who died on the 21st March, 1857), had for some time lived at Durham, and was subsequently appointed Reader in Medicine at the then lately organised University there. He began his lectures in 1833. W. F. Cooke, wishing to make for his father anatomical models in wax to be used at his lectures, went to Paris where he attended, during the winter of 1833-4, lectures on anatomy. In the spring of 1834 he returned to Durham, and made there such models as his father most wanted. In the summer of 1835 he accompanied his parents on a tour to Switzerland. Ascending the Rhine, Heidleburgh was visited. Here Professor Tiedemann, the director of the then existing Anatomical Institute, offerred to assist young Mr. Cooke in procuring the necessary preparations in wax for his father, if he would come back to Heidelberg."

In July last, communication by electric telegraph could be made between London and Tumen, in Siberia, 4039 miles distance. It is expected that the wires will be extended to Nikolaivski, on the Pacific, by the end of this year, and that we shall have telegraphic communication with New York, *via* Siberia and California, by the end of 1863.

The Paris Universal and Permanent Exhibition.—Most readers have heard that a project for forming a permanent Universal Exhibition in Paris, has been received with favour by the Emperor; but many will probably hear with surprise that the building is in progress. It is situate at Auteuil, close to the road and railway, and just within the ramparts The enterprise is undertaken by a company. The estimated cost of the building is £600,000, the whole of which has been subscribed in France. The object is to found a place of resort for producers, dealers, and customers from all parts of the world, where commodities may be compared and purchased under one roof—an arrangement which will afford great facilities to all parties. The shareholders are to be reimbursed by the rentals charged to exhibitors, and the public will be admitted free on at least five days of the week. The building is situate on an irregular-shaped plot of ground, bounded on one side by the new railway, on another by the road of St. Cloud, and flanked by the ramparts. The main building will consist of an open nave, running north and south, presenting a clear and uninterrupted space of 1,050ft. long, 130ft. wide, and 110ft. to the crown of the semicircular roof, which springs at a height of 35ft. from the floor-line. This nave will be intersected by a transept of equal width and height, 550ft. in length, above which a dome will rise to a total height of 345ft. The domes of the London International Exhibition building are 250ft. in height. On each side of the naves there will be aisles, 100ft. in width; and again, on the west side, two supplementary aisles of equal width, but of varied length, planned in accordance with the site. Over all these aisles at a height of 25ft. from the ground, galleries will be constructed. The total length of the building externally will be 1,315ft. At the south end, quite detached, and yet connected with the main building by corridors, will be a polygonal saloon 222ft. in diameter, and 115ft. in height. With its gallery all round, it is calculated to hold 10,000 persons. A machinery annexe, 600ft. long and 100 ft. wide, will occupy the north-east corner of the ground; and near the music saloon will be erected two buildings, of iron and glass to be used as winter gardens. The architect is Mr. Liandier; the contractor Mr. Edwards; and the iron castings are being made in Glasgow by Messrs. T. Eddington and Son. The London agency we may note, is at 27 Leadenhall-street. A considerable quantity of space, we are told, has been already applied for; and it is hoped that the building will be inaugurated early next year.—*Builder.*

To Correspondents.

F. L.—Our columns are always open to fair criticism, but we must request our correspondents to abstain from indulging in harsh and uncourteous expressions. Nothing is gained thereby, but on the contrary, ridicule and contempt are justly provoked. The science of telegraphy affords a wide field for research, and as some of its most illustrious votaries have acknowledged it to be even now in its "infancy," let it therefore be reared tenderly, and not amidst unseemly strife and rancour.

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The Electrician.

VOL. II. No. 47.—SEPTEMBER 26, 1862.

CONTENTS:

	PAGE
Rotary Galvanometers	241
Some Considerations on the Principles of Electrical Conduction and Accumulation	242
On a Unit of Measurement for Voltaic Currents	243
Laying of Submarine Cables	243
Electro-Magnetic Engines	244
On the Metallurgy of Platinum	245
On the Practical Bearing of Electricity in Submarine Telegraphy, &c.	246
Prices Current of Insulating Materials	251
Telegraph Shares	251
Telegraphic News	251
Correspondence	251
Miscellanea	252
To Correspondents	252

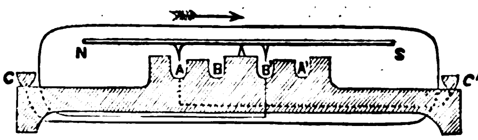
ROTARY GALVANOMETERS.

[Continued from p. 230.]

WE must now seek to explain the failure of our endeavours to produce the rotation of a magnetic needle, by maintaining it constantly parallel to a conductor conveying a current of electricity in a determinate direction in relation to the poles of the magnet. The essential difference between our contrivance and the ordinary form of galvanometer, is that while the wire coil of the latter represents an open magnet, the coiled ring virtually constitutes a closed magnetic circuit. Let us make this quite clear. It is commonly supposed that to construct an electro-magnet it is necessary to coil with wire a piece of soft iron of any required form. This is not strictly the case; if the wire be coiled upon any other substance, or if the coiled wire alone be taken, we have still an electro-magnet, though of far less power than when the magnetic body is used. The function of the soft iron is to develop to the fullest extent the magnetic effect due to the current. The coil of wire of a galvanometer is, therefore, virtually an electro-magnet; and if we insert within it a bar of soft iron, we merely increase its power, without in any way altering its polarity. This electro-magnet, it is to be observed, is of a peculiar form; the distance between the poles being very small, and the *breadth* of the magnet very great. When a magnetic needle is suspended above the coil, and parallel to the turns of wire, it is necessarily in a direction at right angles to the poles of the electro-magnet, and becomes, therefore, deflected in the direction of the latter, when a voltaic current traverses the wire.

If, instead of using a ring of wood or gutta percha in the construction of the instrument, illustrated in fig. 2 of our last article, we take a similar ring of soft iron and coil the wire round it, we shall obtain what is termed a closed magnetic circuit, *i. e.*, an electro-magnet equivalent to two horse-shoe magnets, united by their opposite poles. It follows from what has been said, that this is also the case when the wire is coiled upon a frame of wood or other material. Thus, if the wire be coiled with regularity, a magnetic needle, suspended as in the figure, will be attracted equally by every portion of this *electro-magnet;* and no rotation or even deflection of the needle will take place. These considerations sufficiently explain the failure of the attempts in this direction to obtain the continuous rotation of a magnet. In the apparatus shown in section, fig. 3, p. 230, each ring constitutes a separate closed magnetic circuit, but the conditions do not essentially differ from those in the former case.

Having, perhaps, dwelt sufficiently upon the most instructive, though least "practical" portion of our present subject matter, we may now describe a method by which the continuous rotation of a magnet may be effected. A voltaic current is made to traverse *successively* four or more conductors, so disposed that they may in *turn* deflect the magnet in a determinate direction. To effect this, the magnet itself is made to form a portion of the circuit. By means of the following figure we may be able to explain in detail the construction of the instrument in question, a section of which is given.



In the base of the instrument two circular grooves, A A′ and B B′, are formed; the former of which is divided into four (or more) equal partitions. These grooves are for the purpose of containing mercury, into which dip two pieces of metal, attached vertically to the pivotted magnetic needle N S. In the centre of one of the partitions of A A′ is passed upwards, at A, the extremity of a wire, which is thus in contact with the mercury contained in this partition. The other extremity of the wire is led to the mercury cup C′. Another wire is passed upwards at B′ into the mercury contained in the uninterrupted groove B B′; the course of this wire above the needle, and again beneath the base of the instrument to the mercury cup C, is shown in the figure. For the sake of perspicuity one turn of wire only is shown; but a coil of 50 or more turns may be made to surround the needle, the extremity of the wire being ultimately brought into contact with the mercury in C. One of the circuits, of which there are four, is now complete; the current, when the magnet is in its present direction, passing from the wire at A to that at B, by means of the magnet itself. The magnet is thus deflected according to the direction of the current traversing the wire; but the deflection can continue only until the piece of metal attached to the magnet and dipping into the mercury at A, passes beyond this partition. When this takes place the current traverses another circuit, deflecting the magnet in the same direction as before, as will be understood by what follows.

To form a second circuit parallel to the first, but traversed by a current in the opposite direction, the end of a wire may be passed upwards at B, and the other extremity brought into contact with the mercury at C′. Another wire is then brought into contact with the mercury in the division A′, and passed over and round the magnetic bar, the turns being in the opposite direction to those in the former case, and equal in number. The end of this wire is brought to the mercury cup C.

The third and the fourth circuits, corresponding to the remaining divisions of the groove or trough A A′, are at right angles to the preceding, and are traversed by the current in opposite directions, precisely as in the former case. The extremities of the wire are brought to the mercury cups C and C′, care being taken that the current through each circuit should traverse the wire in the *same direction, in regard to the poles of the magnet.*

The above will probably suffice to enable the student to add a new instrument to those he may already have constructed, for the purpose of illustrating the principal phenomena of electrical action. When the poles of a voltaic couple or battery are connected to the mercury cups C and C′, the magnet immediately begins to rotate with a greater or less velocity, according to the power of the current. The utility of the instrument for the approximative measurement of the quantity of electricity traversing a current is, however, considerably diminished by the employment of mercury, the mechanical resistance of which to the movement of the needle is never constant. Water may be used instead of mercury; in this case, as the surface of the water cannot readily be made to rise above the level of the separating partitions in the outer groove or trough, the pieces of metal attached to the magnet should be moveable, *i. e.*, should be suspended so as to pass readily over these partitions.

IN the use of the platinum battery of Grove, the nuisance produced by the evolution of nitrous vapour is sometimes mitigated by enclosing the cells in a box, from the lid of which a tube proceeds which conducts these vapours out of the room.

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SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

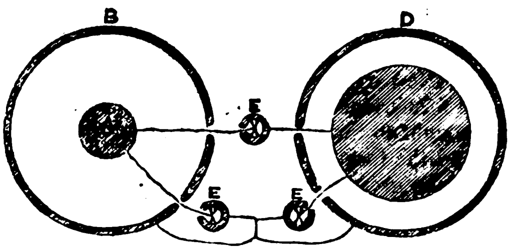
[Continued from page 233.]

It is evident, that in cases such as that represented in fig. 93, and which may be termed cases of *interference* of one charged conductor with another, the distribution cannot be solved by a mere recourse to the simple principles of a distribution inverse to the inductive resistance separating the different surfaces from one another. We cannot, therefore, in such cases, ascertain by this means of calculation the quantity that will pass to the electrometer, and consequently we cannot ascertain, except by actual experiments, the tension between any two points in such a system, as compared to that between any other two, not situated n the same conductors as the previous two. This inadequacy of the principles I am setting forth to complex cases, might be urged against their soundness. When, however, we consider that Green, who has been, perhaps, the most successful in applying mathematics to electricity, observes, that "the complete solution of the simple case of two spheres only, previously electrified, and put in presence of each other requires the aid of a profound analysis," it is evident that the inadequacy of my simple mode of dealing with electrical accumulation to solve such problems, will be no great argument against its general utility, considering its simplicity, and the many other cases to which I have shown that it is applicable; particularly as these problems of spheres acting on one another are of the least value in practice.

When, however, we have distinct resistances separating different surfaces, then we shall find a very simple relation between the quantity, the inductive resistance, and the tension, which may be thus explained:—

Let A and C (fig. 94) be two spherical conductors surrounded by shells, B and D, connected together. Then, for the quantity on A

Fig. 94.



to be in equilibrium with that on C, so that if A and C be joined by a conductor no flow shall take place: the quantity on both must be of the same name, and that on A must be to that on C, as the resistance between C and D is to that between A and B. Thus, if r = resistance between A and B

r' = „ „ C and D

Q = quantity on A

Q′ = „ „ C

Then when Q : Q′ : : r' : r

Or $Qr = Q'r'$, equilibrium will result between A and C, and according as these products of the inductive resistance and quantities depart from equality, so will the tension between A and B, and that between C and D depart from equality.

Hence, if Q quantity on any conductor.

R the resistance between it and its opposing surface.

T the tension between all points in that conductor and its opposing surface, and all points connected with the latter.

Then T = Q R

Or the tension is equal to the product of the quantity by the inductive resistance.

Now, since for A and C to be in equilibrium to one another, or, in fact, to have no tension to one another, the tension of each to B and D must be the same (since Q r must equal Q′ r'), it follows that the greater the difference between their tensions to B and D, the greater will be their tension to one another. Or, generally stated:—

1. *Points which have the same tension, and of the same name to the same point, are in equilibrium, or have no tension to one another.*

2. *The tension between any two points is equal to the difference of tension between those points and any given point, or between those points and any two points which are in equilibrium.*

Let R = 1,000 = inductive resistance of electrometer

„ r = 91 = resistance between A and B

„ r' = 6 = „ „ C and D

„ Q = 15 = positive quantity on A

„ Q′ = 23 = „ „ C

„ T = tension between A and B

„ T′ = „ „ C and D

„ T″ = „ „ A and C

„ q = quantity on electrometer

Then T = Q r = 91×15 = 1365

„ T′ = Q′r' = 23× 6 = 138

„ T″ = T − T′ = 1227

Let us see if, by calculating the quantities according to the inductive resistance, the quantities on the electrometers will be proportional to the tensions calculated.

First, the quantity on the electrometer when at E will be found by the formula—

$q = \frac{Q\,r}{R+r} = \frac{1365}{1091} = 1{\cdot}251$, or A has a tension of 1·251+ to B and consequently to D.

And the quantity on the electrometer, when at E′, will be—

$q' = \frac{Q'r'}{R+r'} = \frac{138}{1006} = 0{\cdot}137$ or C has a tension of 0·137+ to D.

These quantities are not, evidently, to one another as the tensions T and T′, but the reason of this is obvious; the quantities on A and C are altered by the addition of the electrometers, and, consequently, the tensions of A and C have changed, and if we correct for this alteration, we shall see that they represent the tension then existing.

Thus the quantity Q has been deprived of a quantity q, which has passed to the electrometer, hence the quantity on A = Q − q = 15 − 1·251 = 13·749. Hence—

T = 13·749 × 91 = 1251,

and for the same reasons the quantity on C has been reduced by a quantity q'. Hence the quantity on C = Q′ − q = 22·863.

Hence—

T = 22·863 × 6 = 137,

to which quantities the quantities on the electrometer are exactly proportional.

Suppose, now, A to be charged as before, and C to be uncharged; then, since Q′ = 0, evidently Q′ r' = 0, or the tension of C to D is *nil;* and the electrometer at E will indicate this, since it could not evidently be applied. C is in equilibrium with D and consequently with B, and consequently the tension of A to C is the same therefore as from A to B. The electrometer at E″ would not, however, give an indication similar to that which would be obtained at E, because the moment the electrometer is connected to A and C the conditions are altered, and the tension of C to D is no longer zero; and, consequently, that from A to C is no longer the same as from A to B, for a fresh inductive path is open between A and the conducting surface B, and the quantity on A would, therefore, divide itself with the arms of the electrometer in the inverse ratio of the resistances r and r'+R, polarising the whole conductor formed by the armature of the electrometer and the conductor C.

Thus $Q = \frac{q\,r}{r+r'+R} = \frac{15+91}{91+6+1000} = \frac{1365}{1097} = 1{\cdot}2443.$

Or the quantity on the electrometer E″ measuring the tension between A and C is 1·2443, whilst the tension between A and B was 1·365, and measured 1·251 on electrometer E.

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Now, the quantity 1·2443 on the arms of the electrometer is positive, and consequently the armature has also a negative quantity on it equal to this, whilst the conductor C has an equal positive quantity. By calculation, therefore, T′ (the tension of C to D) is now $1{\cdot}2443 \times 6 = 7{\cdot}4658$.

And the quantity on A is now reduced by the quantity 1·2443, which has passed to the arms, and is, therefore, now $15 - 1{\cdot}2443 = 13{\cdot}7557$, and consequently T (the tension between A and B) is now $13{\cdot}7557 \times 91 = 1251{\cdot}76$.

Subtracting, therefore, T′ from T, we get T″ (the tension between A and C)=1244·29, to which tension the quantity (1·2443) on the electrometer E″ is proportional, within less than a ten-thousandth part, which is to be accounted for by not carrying out to sufficient decimals.

In all these cases it will be seen, that as the electrometer, of course, measures the tension only after it is connected, and that then the conditions are altered, the greater its resistance compared to the inductive resistance separating the surfaces between which we wish to measure the tension, the less will be the change in the tension, caused by applying the electrometers. Thus, if we had a submarine cable 100 miles long, then, since its inductive resistance would be almost infinitely small compared to that of an electrometer, the tension would not be appreciably reduced by connecting it to an electrometer; but if we had a piece of cable only six inches long, the tension might be considerably altered in applying to it an electrometer having a small inductive resistance.

If A and C are both charged with a quantity such that $Q\,r$ is unequal to $Q'\,r'$, then the electrometer E″ would be affected, and measure the tension between A and C, and, consequently, the difference between the tension existing between A and B, and that existing between C and D. This case cannot, as far as I can at present see, be solved and traced accurately by the mere law of distribution, according to the inductive resistance; because it is a case of interference, or mutual action, of A on C and C on A, though in a more defined form than that of two charged spheres placed near one another, and I do not entirely despair of bringing such cases under the same simple law.

*** By an omission of our engraver the dashes to two of the letters E, in fig. 94, have been omitted. The right hand lower electrometer connected up between C and D, should be E′, and the central electrometer connected between A and C, should be E″.—ED. E.

ON A UNIT OF MEASUREMENT FOR VOLTAIC CURRENTS.

BY M. MARIE DAVY.

WHEN I received from the *Académie* the encouragement it deigned to bestow upon me, I undertook to devote all my endeavours to the solution of the great problem of the employment of electricity as a motive force. This solution could be furnished only by the production of a motive power performing a useful function under reasonable conditions of economy; for machines worked by electricity *at any cost* were already numerous. In case I should find this solution impracticable in the present position of science—in contradiction to my first anticipations—it remained for me to complete the theory of electro-motors sketched by M. Jacobi, from the point of view of the mechanical equivalent of electricity, and of its theoretical and practical value; to perform for electricity, as far as lay in my power, what has been done for the steam engine. During six years I constantly studied this question, and it is the series of results which were obtained that I propose to submit to the judgment of the Academy, in a number of memoirs, which will be separated from each other only by the time which is necessary conclusively to verify these results, and of the calculations based upon them. In the present memoir, which is, so to speak, but an introduction to those which are to follow, and in which I merely seek to establish a unity in currents, the conclusions are not new; but I considered myself called upon to furnish to men of science every means of verifying my researches, and of determining the limits of precision I have been able to obtain. The following are these conclusions.

1. A current from a constant source, but of which the intensity may be varied by dividing this current between four parallel voltameters, produces deposits of metallic silver, of which the weights are, as nearly as the 2-10,000th part, proportionate to this intensity, between the limits of 10 to 2000, in which I experimented.

2. The deposit of silver effected by several continuous currents, superposed in the same or opposite direction in the same voltameter, is equal to the algebraic sum of the deposits effected respectively by the currents in separate voltameters; whether these currents be furnished by the same or by separate batteries, the result is the same.

Example, 14th Experiment.

	Deposit of silver.
Couple with bicromate of potash	+0·3267 grains.
Couple with salts of lead	+0·0052 „
Couple with sulphate of copper	+0·0065 „
Couple with salt of mercury	−01678· „
Total algebraic	+0·1706 „
The four currents united in the same voltameter, the three first in the same direction, the fourth in the contrary direction	0·1708 „
Difference	0·0002 „

3. The diversity of origin exerts, therefore, no effect on the action of the current in the voltameter, at least in the case of the different batteries with which I experimented, and which are six in number, chosen among those most in use. This, which holds good with these batteries, is analogous to what takes place with different descriptions of fuel.

4. The nature, form, and dimensions of the electrodes, the volume and degree of concentration of the fluid, within the voltameter, and also their temperature, exert no influence upon the quantity of silver reduced when the fluid is neutral.

Example.—Weight of Silver Reduced by the same Current. Experiment 16.

Voltameter A @ 0° ...	0·2573	duration of the experiment 6 hours.
„ B @ 40° ...	0·2570	„ „ „
Difference	0·0003	

On an average of four weighings with a balance which just turns with the tenth of a milligramme.

I confine these propositions to the use of the neutral nitrate of silver, with which I have almost exclusively experimented, because, of all salts, this gives the best results, and as it is here a question of deciding upon my unit of current, I think that one equivalent alone should be considered.

5. A neutral nitrate of silver, therefore, furnishes a precise and practical means of finding at any time or place the conventional unity which may be adopted, and of graduating all galvanometers in accordance with this unit.

6. I choose for my unit of current the thousandth part of that which reduces a hundred and eighty milligrammes in one hour.

LAYING OF SUBMARINE CABLES.

THE following is an extract from a letter addressed by Captain Selwyn to the Editor of *The Mechanic's Magazine*:—

"If any of your readers will take the trouble to look at Captain Dayman's soundings, they will see that there is a distance of about ten miles between each of them wherever this could be done. I have not the book before me at present, but I can affirm that in the presence, and with the assistance of Captain Becher, I examined the latitudes and longitudes of each of the soundings near what has been falsely called the Irish precipice. On reducing the miles distance between those soundings into feet, as also the depth, we found that the rise was abont 1 in 16—a little less steep than Holborn-hill.

"I am credibly informed that even this is more than can be proved to exist since the *Porcupine* has sounded over the ground again. But who in their senses, if it did exist, would think of such a declivity as a "precipice," or try to show that this was the cause of the damage to the late Atlantic cable, unless to cover *peculiar proclivities*.

"'Bad workmen always find fault with their tools.' and the 'moral causes,' which never should have existed, as well as the physical causes, which never did exist, have been far too heavily blamed for shortcomings of the gentlemen who have been learning '*how they cannot do it*.' But the special value of the *Porcupine's* voyage of discovery seems to have been divided between the finding of a 'gap' which nobody wanted, and the survey of a cod-bank, which can surely have very little to do with a cable. On which of these subjects is the Admiralty about to make a communication to the Atlantic Telegraph Company, with a view, of course,

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to the raising of fresh capital, and what will be the security against further loss to shareholders?

"Mr. Cyrus Field, who is certainly a most energetic director, can, I fear, as little galvanize into life a defunct company as a destroyed cable; and one would imagine that the Federal government, who may or may not be now at Washington, have nearly enough to do with what money they have (leaving paper out of the question) without helping us to lay a able.

"If the problem of an Atlantic cable is to be rightly solved, it must be done by a company who have been fortunate enough to profit by the experience, without having incurred the losses incidental to a want of success; and though this may seem hard measure, it is not really so, for companies are not in the same position in this respect as individuals.

"A company may always be re-constituted, and those who lost by the first scheme can always, if they chose, try to recover their loss by a wise use of the experience they have bought. But no person having a choice would be likely to attach himself to an association, which, rejecting experience, fighting against facts, and advocating unnumbered fallacies, should offer only the old encumbrances which have ruined, and the old methods which have failed, backed by a bet that this time it *will* be done, that bet being very much on the principle of 'heads I win, tails you lose.'

"I have lately also seen a notice of the laying of a cable across the North Sea, with the aid of fishing boats stationed at intervals. I hope the said fishing boats will not be brought forward as a good idea for the Atlantic cable; but there is no telling what folly may not be proposed. I confess I think it a very clumsy expedient even where it *was* adopted, and it certainly does not seem to have had the effect of getting rid of kinks. They speak of these occurring, and the '*brave*' way in which they were pulled out. When will cable manufacturers and *layers* be convinced that the wise thing to do is, to avoid making kinks, not to claim credit for pulling them out? and this can only be done by winding on a reel, not coiling in a hold.

"Half or two-thirds the damage which has been ascribed to other causes arises from this source, and it cannot be too strongly impressed on those who study the subject, that a kink may be, and often is, fatal to the insulation of a copper conductor, whether pulled out or not, and certainly never does it any good.

"Another thing is, that no ship ever anchors in water so deep as 60 fathoms, if she can help it, and can very seldom recover her anchor if she does, so that damage from that cause ought to be much more limited than has yet been the case.

"In shoal water there is, no doubt, considerable difficulty from ships' anchors, but this might be met by heavy rewards for conviction of offenders, almost as well as by heavy cables, which involve great difficulty in lifting when damage occurs, which it is sure to do sooner or later. I should prefer, even here, a moderately light cable, with the strength in the centre, for the greater portion to be laid slack, and a considerable reward for every one who, having caught it, threw it off uninjured, or for conviction of any one who wilfully damaged it. There are certain portions of every shore off which vessels never anchor. Let these be chosen for the telegraph route rather than the straightest line between two points, and then the submarine companies may look for a rise in the dividends, and their cables will not be such bugbears in the accounts. This is the reason why some submarine lines *have not cost a shilling for repairs*, while others go far into thousands of pounds for the same purpose. Telegraph companies would often do well to remember that 'the longest way round is sometimes the shortest way home,' under the ocean as well as on it.

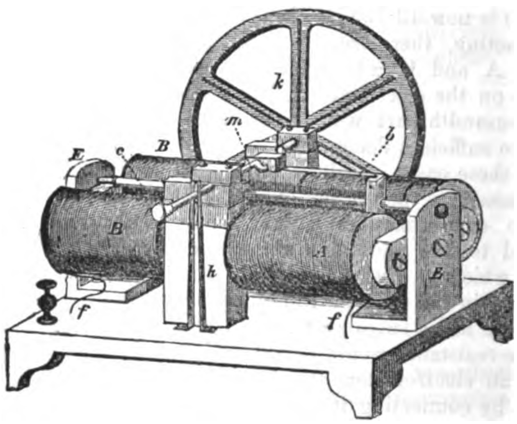
"I was told not long since that some of the leading telegraphic engineers express themselves 'sick of submarines.' I am delighted to hear it, for now the nautical engineer may have a chance of being listened to, and of showing that all science is not confined to those who know nothing of the sea.

"That the difficulties can be, and will be, overcome, that the cable will eventually be laid, I am as confident as that the earth moves. That I may be one of the humble instruments in doing so I fervently hope, and try to qualify myself for—not by ignoring, but by consulting facts—not by pride and prejudice, but by patience, perseverance, and as much sweet oil as I can afford—for fallacies. J. N. SELWYN, Capt., R.N."

"*Chequers Court, Tring, Herts.*"

ELECTRO-MAGNETIC ENGINES.

THE following illustration represents a small working model of an electro-magneto-motive engine constructed by Mr. Bain, with some few improvements by the publishers of Dr. Noad's "Manual of Electricity." On to a stout mahogany board are fixed the brass uprights *E E*; to these are attached the electro-magnets *A B*, covered with stout wire; through the upper part of these uprights, and above the magnets, the two ends of the steel spindle *c* work; this spindle carries about its centre an iron bit, which is alternately attracted by the two magnets *A* and *B*, but prevented from absolute contact by pieces of paper; another spindle *m*, at right angles with *c*, and supported upon uprights, *h h*, carrying at one end the fly-wheel, *k*, and on the other a small pulley, is cranked in the centre and connected with *c* by the spring and hook *b*. At *h* are seen two brass springs bearing lightly on the spindle, which is divided in the middle by a small piece of ivory, so that one only is in contact at the same time. The connexions are formed thus: one termination of the electro-magnet, *A*, is connected to one of the upright springs bearing on the spindle, and the other termination to the binding screws seen at the end of the board. The one termination of the electro-magnet *B* is connected with the other spring, and the other extremity to the same binding screw to which one end of *A* was attached, the remaining



binding screw being in connection by means of a wire with the brass box in which *m* works. The working of this machine is greatly assisted by two spiral springs fixed underneath the board attached to the moving bit. The whole arrangement performs extremely well, and no doubt if made on a large scale would be very powerful.

Mr. Henley gives the following description of two electro-magnetic engines, constructed by him for Mr. Talbot and Professor Wheatstone:—

"Mr. Talbot's engine consisted of 6 powerful horse-shoe electro-magnets, placed in a line with their poles upwards; to each magnet was adapted an armature, to which was affixed a jointed arm; in the centre of the armature was a hole which was fitted to a 6-throw crank, the throws set at an angle of 60° with each other, the currents acting on the magnets in succession from 1 to 6; at the time of breaking at 6 it commences again at 1: contact is made when the armature is at a small distance from the magnet, and is continued till it reaches it; at this moment contact is broken and made with the succeeding one; the connecting rod playing through the hole in the armature allows the crank to pass down; when it remains stationary on the poles of the magnet, a piece of paper prevents adhesion. There is a knob at the end of the connecting rod, by which it lifts the armature in one position, and is pulled in the other. In this machine the magnet acts when the crank is in the very best position, and were it not for the additional friction from the great number of rubbing parts, it would certainly be the best form of machine. On the shaft is mounted an A shaped frame, and at one end carries a heavy fly wheel, and at the other a contact-breaking apparatus, which consists of a wheel and 6 leavers, the points of which dip in mercury."*

The original of Professor Wheatstone's machine consists of a brass ring, within which are placed 8 magnets; an eccentric wheel revolves within, the longest radius of which passes close to each magnet successively, following the current as it were, which acts on each magnet a little in advance of the wheel; the break piece, which is stationary, is made of a piece of ivory, into which are let 8 pieces of brass; the shaft which passes through this without touching, carries a spring which presses on the break piece. The shaft and frame work is in connection with one pole of the battery, one end of the coil on each magnet, and the other end of each with its corresponding piece of brass; the shaft also carries a fly-wheel and pulley to transfer the power. If there were a hundred magnets, of course the same battery would be sufficient, as they only act one at a time.

Mr. Henley has also constructed a machine which works a lathe, it is made with 3 horse-shoe magnets, with their poles upwards, the bent parts crossing each other; a bolt passes through them and holds them firmly to a base: within the pole revolves a soft iron

* This engine was 3 feet 6 inches long, and 2 feet 6 inches wide, but its power was not equal to the expectations that were formed of it; when excited by a Grove's battery, consisting of 4 cells with double plates of zinc 9 inches by 6¼, platinum plates 9 inches by 5¼, excited by diluted sulphuric acid 1 to 4, and concentrated nitric acid, Mr. Henley drove with it a lathe in which he turned a gun-metal pulley 5 inches in diameter, but in three quarters of an hour the battery was quite exhausted. This machine, it will be observed, was something more than a *model*.

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cross; one magnet acts at a time, but the cross is attracted continually. The cross is suspended by 4 stout brass columns. At first there were but 2, it was found necessary, however, to add 2 more to resist the strain of the magnets, as the poles are curved, and the cross passes very close: there is piece of apparatus to stop it immediately—it is a lever, which makes contact with one of the magnets independent of the break piece.

ON THE METALLURGY OF PLATINUM.

BY MM. H. SAINTE-CLAIRE DEVILLE AND H. DEBRAY.

THE manufacture and uses of platinum are interesting in the highest degree to chemists, especially to theoretical chemists, who in their analytical operations so frequently make use of the remarkable properties of this precious metal. We, therefore, ask permission to present some observations and experiments we have recently made to complete the new system of metallurgic treatment we published some years ago in the French scientific serials.*

One of us has had an opportunity of witnessing our processes applied with great success by a clever English manufacturer, Mr. Matthey, of London. An ingot of platinum of 100 kilogrammes was melted in a quicklime furnace with lighting gas and oxygen. Under the influence of these powerful agents the mass became so liquid that it filled exactly with metal every part of the mould, and reproduced all its imperfections with unexpected precision.

The experiment occupied four hours; but as it took about half this time to heat the furnace itself, four hours, short time as it is for such an operation, may be considered as the maximum.

The aspect of this glowing liquid mass was a sight not easily to be forgotten. For this large operation, Mr. Matthey used the gasometer for melting ingots of from 20 to 25 kilogrammes, for which he has daily occasion. It is a surprising fact that, having on this occasion for the first time replaced the manganese or sulphuric acid usually used in the preparation of oxygen, by chlorate of potash, Mr. Matthey decomposed at one time, and without taking any precaution, 22 kilogrammes of it mixed with its weight of manganese. The gas was disengaged with prodigious rapidity; but there is really no danger of an explosion provided the tubes are sufficiently large to carry off the gas. There is even no sensible increase of pressure in the apparatus.

A new process for moulding platinum is now used, invented by Mr. Heraeus, manufacturer at Hanau, and applied with considerable success in London. Mr. Heraeus, by the advice of his illustrious master, M. Wöhler, has adopted for several years the processes we published on the treatment of platinum, which, in the hands of a clever manufacturer and an englightened chemist, have undergone already, as we anticipated, simplication and improvement. M. Heraeus runs the platinum into moulds of forged iron, the use of which he had given up; but he obviates all the inconveniences arising from the fusibility of the iron by placing at the bottom of the mould a leaf of platinum one millimètre thick, which supports the first contact of the fused metal.

Owing to this precaution, the ingots are very perfect, entirely free from those blisters so often visible upon cast metals, from which platinum is no more exempt than the other metals when it has been carelessly moulded.

From observations made in England, it is found that the alembics used in the manufacture of concentrated sulphuric acid are much more durable when fabricated with the cast platinum which Mr. Matthey now exclusively employs for this purpose. The platinum united by Wollaston's process is porous, and frequently allows the hot acid to leak through. We ought, moreover, to warn the manufacturers of platinum that the sulphuric acid prepared with Peruvian nitrate of soda contains a little chlorine, which acts upon the gold solder of platinum alembics with remarkable facility. For this reason it is very desirable to substitute for the gold in these vessels platinum melted by our oxyhydrogen blowpipe, and spread over the surfaces, to be united by the autogenous soldering processes.

This process, utilised for some time in Englsnd, gives excellent results, and from the great difference in value between gold and platinum, effects considerable saving.

One of us has had the opportunity of seeing in the laboratory of Mr. Matthey some tubes cast by this process, and drawn out without defect; and in the laboratory of MM. Desmontis, Chapius and Quennessen, some experiments tried upon cast platinum which promise valuable results.

* See *Annales de Chimie et de Physique*, 3rd Series. vol. lvi. p. 385, and vol. lxi. p. 5; *Annales des Mines*, 5th Series, vol. xvi. p. 1, and vol. xvii. p. 71.

Unhappily, for the development of the platinum manufacture, the enormous price of these alembics has driven the makers of sulphuric acid to substitute for them vessels of lead glass. Seven-tenths of the concentrated acid are now made in England with glass vessels, of which the first cost and expense of repairs are scarcely equal to half the annual interest of the sum necessary to provide a large platinum distillation vessel. The improved apparatus we offer to manufacturers —an improvement already realized in England, we can vouch—consists in an alembic capable of concentrating at least from two to four tons of acid every twenty-four hours, at a price, at most, but a fifth or a sixth of the apparatus actually in use. By this reduction in price, we believe that the workers in platinum will preserve to this metal a market—a reduction to the interest of all, to the interest of our laboratories, our chemical manufactories, and to the platinum makers themselves. The development of platinum manufactures depends also on the Russian Government, which was the first to offer liberal incentives to improve and develop it. From information furnished us by M. Jaunez, a distinguished engineer, well acquainted with the Oural Mines, the yield of platinum ores is easily capable of threefold increase were the sale of these ores freed from all trammels. It is impossible to say at present to what rate the metal itself might fall if extracted by the economical processes we have published. Nor can we foresee the purposes to which the metal may be advantageously applied, its excessive price hindering all trials. It is to be hoped that the Government of Russia, which, on this point, has shown a real love of progress, and has profited by the counsel of its most distinguished scientific men, will make an entire change in a manufacture from which science benefits so largely.

We have called the attention of manufacturers to the advantages accruing, in some instances, from the use of iridium and platinum alloys, particularly of the natural alloy obtained by the direct fusion of the ores in an oxidising atmosphere. To facilitate the introduction of iridium into platinum, we have tried to find an economical way of extracting, by Wollaston's process, pure iridium from the residuums of platinum manufactures, residuums existing in large quantities in all the great factories of Europe. We have had recourse to the method of attacking by baryta, and in the interest of manufacturers we ask permission to describe summarily the operations. We took:—

Osmide of iridium, or residue*	100 parts
Nitrate of baryta...	100 „
Baryta	200 „

After being pulverized and well blended, the mixture is put into an earthen crucible and made red hot. The black matter and fritt resulting from this calcination is pulverised anew, and is put by small portions into cold water, until the mass is well moistened. Nitric acid is carefully added to it, and the mixture is heated in a sand bath, either before a good chimney to carry off the osmic acid vapours which arise, or in a distilling apparatus; if it is wished to collect them, they can be fixed by caustic ammonia. When all osmic colour has disappeared, and enough nitric acid has been added to make the mass perfectly liquid, pour into the liquid a very small quantity of hydrochloric acid, until the whole becomes of a yellowish red colour. Heat again; then pour into a funnel stopped up with gun-cotton, or into a sugar mould. The liquid, which flows slowly, contains chlorides of platinum, iridium, rhodium, and salts, with common metal bases. But the nitrate of baryta, being insoluble in liquid acids, remains on the funnel impregnated only with metallic chlorides. Displace these with a little pure water, as in the sugar-refining process, and pure nitrate of baryta remains, not being carried away in any appreciable quantity with the dark, thick liquid flowing through the funnel. We thus obtain:—

Nitrate of baryta ... ... 474 parts

This nitrate of baryta, which contains a little unattacked substance, serves for a fresh operation.

As to the liquid containing the precious metals, a few drops of sulphuric acid will free it from all trace of baryta, and then it is to be treated by the processes described in our memoir to which we refer.

In this way we have obtained, with three specimens of platinum prepared by precipitation by means of iron:—

	I.	II.	III.
Iridium with platinum	33·1	38·7	52·9
Rhodium...	20·0	5·9	8·1
Palladium	0·2	—	—
Osmium, common metals, and loss	46·7	55·4	39·0
	100·0	100·0	100·0

* These residuums were kindly lent to us by Mr. Matthey, whom we take this opportunity of thanking for the intelligent and disinterested assistance he has in many instances afforded us.

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In the first of these operations the amount of unattacked matter was 0·15 per cent.; in the second, 0·2 per cent.; in the third it was imperceptible. These figures annul M. Claus's objection that, in our analytical process founded on the same method, the rhodium was not entirely attacked by the baryta.

Mr. Matthey has modified this method by replacing the baryta, which we used to diminish the fusibility of the mixture, and which is very expensive in England, by nitrate of baryta itself, which is very cheap.—*Comptes. Rendus*, liv. 1139.

ON THE PRACTICAL BEARING OF THE THEORY OF ELECTRICITY IN SUBMARINE TELEGRAPHY, THE ELECTRICAL DIFFICULTIES IN LONG CIRCUITS, AND THE CONDITIONS REQUISITE IN A CABLE TO INSURE RAPID AND CERTAIN COMMUNICATION.

BY S. ALFRED VARLEY, ASSOC. INST. C.E.

In accordance with the promise we made some time since, we now reproduce the paper of Mr. S. A. Varley, read before the Society of Arts, March 30, 1859. At the present date the paper is yet instructive; but it specially merits consideration as having been written at a period when the careful series of experiments submitted to the Government Committee were yet unpublished, and when the most erroneous ideas were prevalent in regard to the chief problems of submarine telegraphy.

Since the practical realization of the electric telegraph, several valuable communications connected with the subject have, from time to time, been laid before this Society.

These papers have generally treated of the mechanical details and improvements in the apparatus which have been designed and brought forward by various patentees and inventors.

In the course of the discussions which have taken place it has appeared to me that the principles of the science of electricity have not always been sufficiently appreciated, and the practical value of many of the beautiful contrivances not elicited, from not having determined clearly the principles of the science which are involved in telegraphing, and, consequently, the properties which are essential, and must be possessed by all apparatus, to give them a practical value.

This feeling has led me to think that a paper on the Theory of Electricity, keeping always in view its bearing on electric telegraphy, and which should rather treat of the principles of telegraphic apparatus than confine itself to special contrivances, would be subservient to the progress of the object we have in view; for it must not be forgotten that although the world is always indebted to the practical man for the application of science to commercial purposes, and, in the case of the electric telegraph, it is even questionable whether we are not indebted for its very rapid extension in part to the inability of the projectors to appreciate difficulties which the philospher, foreseeing, would have hesitated at—or, perhaps, to the greater faith possessed by the practical man in the ability of science to overcome whatever difficulties may present themselves; yet, it must not be forgotten that, in the principles of a science, the philosopher is often far ahead of the practical man, and the latter at times comes suddenly and unprepared upon difficulties, which, had he understood correctly the principles long before developed by science, he would have been led to expect as natural consequences. As an example of this, I would mention the case of electric induction, which manifested itself so strikingly when the system of subterranean circuits was considerably extended on the introduction and successful manipulation of gutta percha.

This phenomenon was unexpected and unlooked for by many, though not all, of our practical electricians; and we find it referred to, and regarded at the present time, as a new fact which the electric telegraph has brought to light, and not one to have been anticipated; yet the laws of induction were beautifully and clearly developed by Dr. Faraday, as far back as 1838; and, when called upon to examine this new telegraphic difficulty, we find him alluding to it in an instructive lecture, delivered before the members of the Royal Institution, as a strong confirmation of the truthfulness of views he had put forth as far back as 1838. I would direct attention particularly to this, because I cannot help feeling that our progress is too often obtained by a laborious perseverance in almost empyrical experiments, until, by the laws of chance, a successful result is hit upon, instead of endeavouring, in the first place, to develop a guiding principle, and referring back to it as each step forward is made, to test both the truth of the principles laid down and the correctness of the conclusions arrived at. Were this done, experience would not be paid for so dearly; and the commercial application of a science would not be almost paralysed, as it sometimes is on its first introduction, by the costly series of experiments which have to be gone through before correct principles of working are established.

During March, 1858, the subject of telegraphic cables was very fully entered into by the Institution of Civil Engineers. Finding at that time that there were no papers on the electrical portion before the Institution, and feeling that the subject could not be fully considered without the electrical part being entertained, I was induced at the eleventh hour to attempt to supply the deficiency. Some explanation is, perhaps, therefore, due from me for bringing forward, so shortly afterwards, another paper on almost the same subject. Owing to the large number of evenings which had already been occupied in the consideration of the mechanical portion of the problem, and the late hour at which my paper was submitted, it was only read in abstract, and no discussion taken upon it. The views too, I then brought forward were opposed to some which have lately been laid very prominently before the public, and no opportunity given to contradict them, or to verify their correctness; and as I am convinced that so far from the subject being exhausted, its importance is only now beginning to be appreciated, the opportunity having been offered to me to bring the matter before the Society of Arts, I determined to avail myself of it.

The complete way in which the subject was taken up by the Institution of Civil Engineers is, however, I am glad to say, already bearing fruit; and since the publication of the papers by the Institution, several valuable discussions have taken place in the scientific journals, and in some of the remarks I have to lay before you to-night, I find, to a certain extent, I have been anticipated.

The generally recognised theory of electricity, as I understand it, supposes all bodies in their normal condition to have two powers or forces resident in them directly opposite in their character, being exactly balanced; in bodies in their natural state these forces are completely neutralized and rendered inactive, producing the ordinary condition of matter.

To these powers the name of electricities has been given, and although we are still as ignorant at the present day, as the ancients themselves, with regard to what electricity actually is, yet the fact of the existence of the electric telegraph is a proof of the progress which has been made in a knowledge of the laws, at least, which govern electric phenomena.

In the year 1838, Dr. Faraday clearly developed the principles of induction and conduction, since which time no further progress has been made in the fundamental truths of the science, though much has been done to confirm their correctness, and to develop their consequences.

In the *Philosophical Transactions* for 1838, will be found Dr. Faraday's views on the subject of induction and conduction; and these, to my mind, so clearly explain all electric phenomena, that it will be as well at once to refer to them before proceeding further. After giving reasons for his belief in the identity of induction and conduction, he says, "all these considerations impress my mind strongly with the conviction that insulation and ordinary conduction cannot be properly separated when we are examining into their nature, that is, into the general law or laws under which their phenomena are produced. They appear to me to consist in an action of contiguous particles dependent on the forces developed in electrical excitement; these forces bring the particles into a state of tension or polarity, which constitutes both induction and insulation, and, being in this state, the continuous particles have a power or capability of communicating their forces one to the other, by which they are lowered, and discharge occurs. Every body appears to discharge, but the possession of this capability in a greater or smaller degree in different bodies, makes them better or worse conductors, worse or better insulators, and both induction and conduction appear to be the same in their principle and action, except that in the latter an effect common to both is raised to the highest degree; whereas in the former it occurs in the best cases in only an almost insensible quantity.

In part the 2nd of the *Philosophical Transactions* of the same date, will be found a summary of Dr. Faraday's views, which I will also quote:—

"1st. The theory assumes that all the particles, whether of insulating or conducting matter, are, as wholes, conductors.

"2nd. That, not being polar in their normal state, they can become so by the influence of neighbouring charged particles, the polar state being developed at the instant, exactly as in an insulated conducting mass consisting of many particles.

"3rd. That the particles when polarized are in a forced state, and tend to return to their normal or natural condition.

"4th. That being, as wholes, conductors, they can readily be charged either bodily or polarly.

"5th. That particles which, being contiguous, are in the line of inductive action, can communicate or transfer their polar forces one to another more or less readily.

"6th. That those doing so less readily require the polar forces to be raised to a higher degree before this transference or communication takes place.

"7th. That the ready communication of forces between contiguous particles constitutes conduction, and the difficult communication insulation; conductors and insulators being bodies whose particles naturally possess the property of communicating their forces easily, or with difficulty, and bodies having those differences, as they have differences of any other natural property.

"8th. That ordinary induction is the effect resulting from the action of matter charged with excited or free electricity upon insulating matter, tending to produce in it an equal amount of the contrary state.

"9th. That it can do this only by polarizing the particles contiguous to it, which perform the same office to the next, and these again to those beyond; and that thus the action is propagated from the exciting body to

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the next conducting mass, and these render the contrary force evident in consequence of the effect of communication which supervenes in the conducting mass upon the polarization of the particles of that body.

"10th. That, therefore, induction can only take place through insulators; that induction is insulation, it being the necessary state of the particles, and the mode in which the influence of electrical forces is transferred or transmitted across such insulating media."

To determine for myself the law which induction obeys, in conjunction with my brother, Mr. C. John Varley, I have tried some experiments.

The principle upon which these were based was that of the dual character of electricity, and the fact established by Dr. Faraday, that all statical charge is sustained solely and entirely by induction.

In bodies in their normal condition, the opposite forces or electricities being balanced and united, no attraction for neighbouring particles exists, but when these forces are separated, as in the case of a Leyden jar, the attraction which a given quantity of electricity exerts for the similar amount of negative on the opposite coating, will be less in proportion to some law, as the thickness of the dielectric intervening is increased.

It was therefore assumed that the amount of free attraction under these circumstances, or more correctly the amount of induction which would be thrown upon neighbouring bodies, would increase inversely as the attraction between the opposite coatings diminished.

The apparatus made use of was constituted in the following way:—

A glass pillar, varnished, for better insulation, was mounted upon a board. On the top of this a brass plate was attached, and upon this plate the dielectric to be examined was laid. Over the dielectric another brass plate was then placed.

A Leyden arrangement was thus constructed, the upper and lower brass plates representing the inner and outer coatings of an ordinary Leyden jar.

A brass ball, suspended from a balance which had an adjusting arrangement, so that it could be raised or lowered, hung over the upper metal plate at a short distance from it.

The *modus operandi* was as follows:—

The upper brass plate was connected to the earth, and a series of sparks, through the medium of a sliding rod kept at a fixed distance from the prime conductor of a frictional machine, thrown into the lower brass plate of the Leyden arrangements, or the prime conductor was kept fully charged, and a carrier ball attached to a long glass rod was made use of to measure out definite quantities of electricity.

The room in which the experiments were performed, was heated with a stove, and the dryness of the atmosphere indicated by a hygrometer, so that the insulation might be as perfect as possible.

When a certain number of sparks had been thrown into the lower brass plate the upper brass plate was disconnected from the earth, and the lower one attached to the balance, and if the tension of the charge was sufficient, the brass ball suspended from the balance was attracted down, and discharge ensued. The experiment was repeated again and again, and the number of sparks requisite to just attract the ball down, noted.

Glass plates were the dielectric employed, and the experiment was tried first with one plate, then with two, and then with three plates of glass between the upper and lower brass plates, the brass ball suspended from the balance being kept always at a certain fixed distance from the upper brass plate.

The results obtained from a numerous series of experiments were—that when two plates of glass were placed between the brass plates, only half the number of sparks which were required to raise the tension of charge sufficiently to cause discharge when one plate of glass separated the brass plate was requisite, and when three plates of glass divided the upper and lower brass plates, then a third of the number of sparks raised the charge to the same degree of tension, showing that through flat plates of glass induction decreases in the inverse proportion to the thickness of the dielectric, that is to say, if the induction through one be 12, through 2 it will be 6, through 3—4, and so on.

In the case of a gutta percha covered wire, it was anticipated that as when the thickness of the gutta percha is increased, the outer surface increases at the same time, the decrease of induction consequent on the increased thicknessof the insulating material would not be inversely proportionate to the depths of the gutta percha, but would follow some other law.

To put this to the test, a series of Leyden arrangements were constructed in the following way:—three pieces of tube of half an inch internal diameter, and 2 feet 6 inches long, were placed in the centre of tubes of 2 feet long, the internal diameters of which were 1 inch, 1½ inches, and 2 inches, and the space between the inner and outer tubes filled with melted resin.

By this means three Leyden arrangements, with a uniform internal surface, but whose insulating material varied in thickness in the proportion of 1, 2, and 3 were constructed, and the same process as that already described with the flat plates was repeated.

The results obtained are shown in the annexed table.

Diameter of Inner Tube.	Thickness of Insulation.	Diameter of Outer Tube.	Inductive Force.
10	5	20	22
10	10	30	15·5
10	15	40	11·5

These results were very constant, but as resin was the only dielectric employed, the experiment requires repeating with other dielectrics, for there is reason to believe, that with glass at least, the decrease in induction consequent on an increased thickness of the dielectric, would be somewhat greater than that indicated in the above table.

The reasons for this belief are the following:—When a galvanic battery is connected with the inner and outer coatings of a Leyden arrangement, induction will take place through the dielectric, and if the surfaces of the two coatings are equal, then the force will be equally divided over them; that is to say, if the battery force be 100, the tension of the charge on the one coating will be 50, and that on the other will be 50 also=100.

Let the surface of the outer coating be supposed to be infinite in extent, then the tension of the charge on the inner coating will approach infinitely near to 100, and the tension of the charge on the outer coating will be almost *nil*. An example of this we have when the earth represents one of the coatings of a Leyden arrangement; and this is the case in the prime conductor of a frictional machine, and also in the suspended wire of a telegraphic circuit; in these two examples the prime conductor of the machine and the wire of the telegraphic circuit represent the one coating, the air the dielectric, and the earth the other coating.

Now consider a case where the outer surface is double that of the inner one, the tension of the charge on the inner coating will then be double that of the *outer;* an example of this we have in the above table, where the inner surface is 10, the thickness of the insulation 5, which may here be regarded as unity, and the outer surface 20—the battery force being 100. Divide this into three parts, and we get 33⅓. Give two parts for the tension of the charge on the inner coating, and one part for the tension of the charge on the outer coating, then we shall have for the tension of the inner surface, 66⅔; for the outer surface 33⅓=100 when united.

Now, consider the third example in the above table. Inner surface 10, thickness of insulation 15, outer surface 40, or quadruple that of the inner surface. In this case the tension of charge on the inner surface will be four times that of the charge on the outer surface. In other words, the tension of the charge on the smaller surface will be 80, and that of the outer surface 20, the united tensions equalling 100; but the thickness of the insulation is 15, or three times that of the first example; and it has been shown that induction decreases in the inverse proportion to the thickness of the insulating material; we shall therefore have to divide by 3, and this will give 26·8 for the tension of the charge on the inner surface.

In the first example it has been shown, that if the force be 100, the tension of the charge on the inner surface will be 66⅔, which, to avoid fractions, we may regard as 67. In the actual experiment the inductive force measured was 22; 67, therefore, represents 22, and as 67 is to 22 so should 26·6 be to the amount of force which would be expected to be obtained in the last example; this, when calculated by a simple rule of three sum, gives 8·8 for the amount of inductive force. In the actual experiment the force obtained was 11·5, a result sufficiently near to warrant further investigation, to ascertain whether the law which would seem to be indicated is correct, and whether it holds good with any other dielectric, such as glass, in which case the cause of the discrepancy, when resin is the dielectric employed, should be sought after.

I now proceed to conduction.

The law which governs the conduction of electricity has been very accurately ascertained, and would seem to follow the same law as induction, that is to say, if the sectional area be uniform throughout, the resistance which a conductor will oppose to the passage of a current will be directly relative to its length; or, the length of the conductor being determined, the resistance will be relative to its sectional area. In other words, a wire one mile long will oppose half the resistance of that which will be opposed by a similar wire two miles long; and two wires, each two miles long, placed side by side, which is the same thing as one of twice the sectional area, will oppose exactly the same resistance as a single wire one mile long.

The next thing to be considered is the part which the quantity and intensity of electric currents play in electric phenomena.

The amount of force developed by an electric current, whether it be the deflection of a needle, the attraction of an armature in an electro-magnet, or the decomposition of water, is always relative to the dynamic quantity flowing.

This fact has been well established, and the difference between quantity and intensity accurately defined; yet still, in practice, there is a want of a clear comprehension of the relationship of those terms.

Let a battery—say of ten pairs of elements, with ten inches of surface in each cell—be joined through a circuit perfectly insulated, and opposing very great resistance to the passage of the current; and the amount of force, or in other words, the dynamic quantity of electricity flowing, be weighed off by a magnetometer, and noted down. If now this battery be disconnected, and another of the same number of elements, but with twice the surface, be connected in its place, practically no more will be found to be flowing through the circuit than in the former case, the resistance which the wire opposes measuring out the quantity passing, somewhat in the same way as the height of the column, and not the quantity of water in a cistern, regulates the rate at which it flows from an orifice inserted in it

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Let the series be increased, and more will be urged through; and, if the number of cells be sufficiently numerous for practical purposes, the same dynamic quantity as a single cell would generate through a circuit of no resistance, will be found to be flowing.

In theory, this point can only be approached, for the resistance of the wire can never be completely overcome. In theory, also, when the number of elements is not increased, the larger the surface the greater will be the dynamic quantity flowing, for the tension of the current is lowered in proportion to the amount of electricity flowing out of the battery; and, when drawing from a large reservoir, which batteries of greater surface may be compared to, this same amount will not lower so much the general tension; consequently, there will be more intensity to urge the current through. But to return to practice. If the number of cells has been sufficiently extended, so as to generate the same dynamic quantity as a single cell does through a circuit of nominally no resistance, a further addition to the series will not be attended with any beneficial effect, for there is already power enough to urge through all the electricity the battery is capable of generating; and the force developed is directly relative to the dynamic quantity flowing. Tension is only the medium by means of which this dynamic quantity is forced through the circuit.

It will be as well, perhaps, to define more precisely what is wished to be understood by the term resistance. When it is said that one circuit opposes twice the resistance of another, it is meant that the same tension of current will force half the dynamic quantity only through this circuit that it would through one opposing half the resistance; it follows that a given length of wire opposes the same resistance to half the dynamic quantity of electricity that half this length of wire does to double the dynamic quantity; and hence, all circuits oppose to an infinitely small quantity of electricity an infinitely small amount of resistance.

The way in which quantity and intensity affect practical telegraphing has next to be considered, and whether there be any advantage in employing comparatively large over smaller dynamic quantities of electricity.

It may be generally stated that when the insulation is very perfect there is no great difficulty in working with minimum quantities; but when the insulation is imperfect, larger dynamic quantities hold out a better prospect of working through.

When a current is flowing through a circuit which offers, practically speaking, no resistance, let the cells of the battery be ever so numerous, it will possess no intensity worth noticing, for, as there is no resistance opposed to the force resident in the battery, the intensity is not brought into play. It is something like a powerful engine raising a light weight, the force is latent, but not brought into action.

Let the battery, however, be connected through a circuit opposing considerable resistance; its intensity will then be developed.

Let us imagine a circuit which fulfils these conditions, one end of the wire dipping into the earth in the usual way, and the other connected with the copper pole of a battery composed of a numerous series of elements possessing very little surface, and, consequently, capable of generating only a small dynamic quantity of electricity, and let the circuit be completed by connecting the zinc pole to the earth.

The current will flow from the copper pole through the wire, thence to the earth, and back to the battery, and its working intensity will be dependent on the resistance which the circuit opposes, and can be measured in the following manner:—

Let another battery, but with a smaller number of elements, be connected side by side with the larger battery to this wire, the zinc pole being connected to the earth, and the copper to the wire, and introduce galvanometers in the circuit, between the large battery and the wire, and between the small battery and the wire, so as to indicate the direction in which the currents are flowing.

Both batteries will desire to send a current through the circuit in the same way; but should the small battery oppose much less resistance to the passage of a current through itself than is opposed by the long wire, then the greater quantity of electricity generated by the large battery will pass that way in preference to through the wire, and paralyze the the action of the smaller battery; but if cell after cell be added to this little battery, when its intensity becomes greater than the resistance of the wire, a current will flow from it also in the same direction as that from the large battery through the wire, and the number of cells requisite just to do this will be an axact measure of the working intensity of the current.

Let the case now be considered where the insulation is not perfect; if there be sufficient leakage to let the small dynamic quantity which the battery can only generate, escape on the road, no appreciable amount will reach the further end, the tension of the current will be lowered, and a less number of cells in the little battery will now be found to balance it.

Adding to the number of these small pairs of elements will not give any appreciable assistance, but let the surface in each of the cells of the larger battery be increased so that the greater quantity may be generated than can escape through the leaks, an appreciable amount will then reach the further extremity, and the telegraph instrument be rendered active. In such a case as this, adding quantity will raise the working intensity of the current, whilst increasing the intensity of the battery alone will scarcely affect it.

In some experiments tried by my brother, Mr. Cromwell Varley, and myself, on long leaky circuits, increasing the surface of the batteries alone, without adding to the series, raised the deflection on the galvanometer from 22° to 53°; and the last intelligible words uttered by the Atlantic cable, "Daniells are now in circuit," is a further testimony of the correctness of what has just been advanced.

The correctness of considering the inductive phenomena which manifest themselves in subterranean and submarine circuits, as a new fact suddenly brought to light, has been called in question in the early portion of this paper; a few words on its history will, therefore, not be out of place, before considering the way in which it affects telegraphing.

In 1838, Dr. Faraday pointed out the conditions which would cause the retardation of an electric impulse in its passage through a conductor.

In 1848, the electric telegraph was in actual operation. The method adopted at that time for the insulation of the wires passing through towns, was to enclose a number of cotton covered wires in a leaden tube, and then fill the tube with a mixture of resin and Stockholm tar.

Reasoning on Dr. Faraday's observations, my brother, Cromwell Varley, was led to think that such circuits possessed conditions favourable for induction to manifest itself; he, therefore, searched for it, and succeeded in obtaining indications of induction.

In 1849, gutta percha had been introduced, and as the insulation in gutta percha covered wires was much more perfect than in the cotton covered ones enclosed in leaden pipes, induction manifested itself much more strikingly, and my brother made use of from that time as a more searching test of the perfection of the insulation than the deflection of a galvanometer, the capability of the wire to retain, for a certain period, the induced charge, and he stood alone for some time in making use of this test, others not having faith in it at that period, and in the same year he obtained indications of induction in an overground circuit.

In the latter end of the year 1851, my brother was enabled to experiment upon a length of ten miles of gutta percha covered wire. At these experiments I assisted, and the conclusion he arrived at was, that if gutta percha covered wires were employed for circuits of any length, as was at that time proposed, induction would manifest itself so powerfully, as to offer serious obstacles to telegraphing with the apparatus then in use, the truth of which prediction was subsequently verified. In Prussia, however, as early as 1850, Mr. W. Siemens had employed gutta percha covered wires for circuits of considerable lengths, and encountered the inductive phenomena, an account and explanation of which he published during that year.

This fact was not known on this side of the channel until after gutta percha covered wires throughout the whole lengths of the circuit were also employed in this country, and that was in the year 1854.

To Dr. Faraday, however, is due the whole credit in this matter, and I have only alluded to its telegraphic history, as I cannot help feeling it as a sort of reproach to practical electricians that it should go forth that induction, which was manifesting itself, step by step, before their eyes, came suddenly and unexpectedly upon them. The following extract from Dr. Faraday's researches of 1838 is so instructive, and teaches such a valuable lesson, that I cannot refrain from quoting it. Alluding to Professor Wheatstone's well-known experiment, he says;—"If the two ends of the wire were immediately connected with two large insulated metallic surfaces exposed to the air, so that the primary act of induction, after making contact for discharge, might be in part removed from the internal portion of the wire at the first instant, and disposed for the moment on its surface, jointly with the air and surrounding conductors; then, I venture to anticipate, the middle spark would be more retarded than before, and if these two plates were the inner and outer coatings of a large jar, or Leyden battery, then the retardations of that spark would be still greater."

Previous to the first attempt to submerge the Atlantic cable, a series of experiments were undertaken by the company's late electrician, and the result published.*

These experiments having been tried, at the expense of much capital, and with opportunities which never before presented themselves, are too important not to be noticed, though it is believed that the author of them has lately had reasons to modify some of his conclusions.

The chief results published were these:—

1. That no adequate result is obtained by increasing the sectional area of the conductor; that, in fact, in the case of a submarine circuit—a small wire will transmit signals more rapidly than a larger one.

2. That an insulated submarine wire conducts according to a different law to that of a suspended circuit.

3. That the rate at which a voltaic signal travels is not affected by the intensity of the battery.

4. That magneto-electric induced currents have the property of travelling in the first place faster than voltaic ones; and, unlike voltaic currents, when their intensity is increased their rapidity of travelling is increased also.

In the paper I submitted last March to the Institution of Civil Engineers, I pointed out what I conceive to be errors in these results, and endeavoured to show that some of them necessarily followed from the way in which the experiments were conducted, and I cannot more clearly ex-

* *Vide* "The Atlantic Telegraph. A History of Preliminary Experimental Proceedings, &c., published by orders of the Directors of the Company."

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press what I wish to convey on this head than by quoting my own remarks on that occasion.

"In examining these conclusions, it has first to be considered whether the conditions of a submarine circuit and a suspended one are different. In a suspended wire, the insulating medium of the air takes the place of the gutta percha of the submarine circuit. The earth, which is the nearest conductor, is a considerable distance off, and is only on one side of the wire, therefore but little induction can take place between the wire and the earth; nevertheless, induction to a certain extent does take place, and can be perceived in circuits of very moderate length.

"The author has noticed indications of it in a circuit 60 miles long, and he feels confident that, with delicate apparatus, it could be perceived in much shorter circuits. If the distance between the wire and the earth were decreased, induction would be developed more strongly, and the wire could be brought down, step by step, until the condition of a submarine circuit would be approached, where the earth surrounds the circuit on all sides, and is only separated from it by the thickness of one-eighth or three-sixteenths of an inch of gutta percha—a substance possessing, moreover, specifically, a much greater inductive capacity than air. It, therefore, appears, that the conditions are precisely the same, only differing in degree. Before proceeding further, and to prevent the possibility of mistake, it is desirable to make the following quotation from the work previously referred to:—*

"'The law of squares may possibly apply to the transmission of electricity freely along simple conducting wires; but it certainly does not apply to the case of its transmission along submarine and subterranean gutta percha covered wires (the facility of transmission being estimated by rate of speed), because, in this, the case is not one of simple conduction, but of transmission, after the wire has been charged inductively to saturation as a Leyden jar.' This quotation shows clearly the reason for concluding, that small wires are better conductors for submarine circuits, as far as transmission is concerned, than larger ones; for the smaller the Leyden jar, the more quickly will it be charged to saturation. The author, in differing from these conclusions, does not wish it to be understood that he thinks the law of squares is applicable to submarine wires; but he submits that there is a material difference between a Leyden jar and a submarine wire.

"In a Leyden jar the inner and outer coatings are perfectly insulated one from the other. If they were not insulated there could be no statical charge, as is well understood by all electricians. Induction, therefore, *involves insulation.* But in a submarine circuit this is not the case. If the wire at the further extremity was disconnected from the telegraph instrument, and sealed up with gutta percha, the conditions would be nearly the same. In practice, however, it is quite open through the instrument to the earth, and the resistance opposed by the very long length of wire is the only insulation between the inner and outer coatings, for it unites both, being in connection with the earth at both ends. It is therefore evident that if the wire offers no resistance there will be no insulation, and, as a consequence, no induction to retard the passage of the current. It is also equally plain that precisely in proportion to the resistance which the wire opposes, provided always the insulating medium be of the same thickness, will induction manifest itself and retardation be experienced.

"There is also another difference between a Leyden jar and a submarine circuit.

"The Leyden jar is charged uniformly all over, whilst in a submarine wire the tension of the charge varies in different portions of the circuit, being at its maximum at the end where contact is made with the battery, and dying off to nothing at the further extremity."

The next consideration is the part induction plays in submarine circuits of any considerable length.

In a submarine circuit the wire is insulated from the earth by only a thin layer of gutta percha; the conditions therefore are favourable for induction through the insulating material; the conducter itself, from its great length, opposes very great resistance, or, in other words, insulates to a very considerable extent.

When a battery is connected to send a current, the first impetus is in part directed forward, in part diverted laterally; but as the wire opposes considerable resistance to the passage of the electricity which the battery can generate, whilst the thinness of the insulating material is very favourable for induction taking place through it, the greater portion of the first rush will be occupied in charging the wire statically at the battery end; as, however, it is a balance of forces between the resistance which the wire opposes on the other hand, and the ease with which lateral induction can take place on the other, a very minute portion must pass through instantly, and the period which will elapse between the making contact with the battery and the observing the current at the further extremity will depend upon the capability of the instrument to record very small quantities of electricity. In fact, immediately on contact being made with the battery, a wave will be formed throughout the length of the wire.

When the battery has been disconnected from the wire, the opposite waves will still continue to unite, but the rate of flow as the tension falls will become slower and slower.

* *Vide,* "The Atlantic Telegraph," page 23.

In theory the time which would be occupied by a wire discharging itself completely in this way, would be infinite. In practice, the wire requires a very appreciable time to charge, and a longer period to discharge. The effect of this is, that if currents are sent at all rapidly one after the other, instead of obtaining a series of distinct impulses at the further extremity, an undulating continuous current is received; and, as to obtain a telegraphic signal, the wire has not only to be charged to a certain degree of tension before an appreciable current is received at the further end, but has also to be discharged afterwards before another signal can be sent, the impulses which are obtained through such circuits as these are very sluggish.

The problem to be solved is the best means of reducing the amount of induction, and of mitigating its effects.

Almost the first remedy suggested when this inconvenience was experienced, was to substitute another insulated wire in the place of the earth or a return circuit, for it was argued that, as in this arragement, one wire would be charged positively and the other negatively, they would neutralize one another.

This suggestion was put to the test and failed. Since that time the same plan has been revived by several others; a good deal of argument has also been brought forward lately in support of it, and even amongst those, who know its practical inutility, there would still seem to have been urking some faith in the capability of the method (in theory at least) to neutralize the effects of induction.

The explanation of its failure, if we are guided by the first principles of the science, appears to me to be very simple, and I expect not only to make it plain that no advantage is to be obtained by the adoption of this method, but that it will increase the retardation.

Let two long gutta percha covered wires, buried in the earth, be connected, one with the zinc pole and the other with the copper pole of a battery, and let the farther ends of each of these wires be hermetically sealed. The earth, from its mass, being a perfect conductor, its action, it is evident, will be the same as if metal tubes in metallic communication with each other surrounded the gutta percha wires. It is, therefore, clear that the only retardation to induction will be the thickness of the gutta percha covering, and the tension of the statical charge will be in accordance with the intensity of the battery. Now, consider the case of a similar gutta percha wire of the same length as one of these, but in which one pole of the battery is connected to the earth, and the other to one end of the metallic conductor, and the circuit completed by connecting the further extremity to the earth. It will also receive a statical charge to a certain degree, but the tension of the charge will not, *ceteris paribus*, be dependent upon the intensity of the battery, but upon the resistance which the wire opposes, for it has already been shown that this is the only real insulation between the wire and outer coatings, and that the degree to which statical charge can take place depends on the amount of insulation existing.

Now, let the ends of the two wires which are hermetically sealed be connected to each other, the circumstances are quite as favourable for induction as in the wire in which one end was connected with the earth, but there will be twice the resistance; in other words, double the amount of insulation, and, consequently, a proportionate increase in the amount of induction.

Another view of this matter will, perhaps, assist to confirm what has just been stated.

It is a well established fact, that when a telegraphic circuit is composed of a loop of wire, it will oppose the same resistance as a circuit of double the length where the earth is made use of in the place of a return wire, and this proves that the earth offers no appreciable resistance. If this be the case, what difference can it make whether the battery pole be carried to the end of the wire itself, or through the medium of any length of a perfect conductor, which the earth has been proved to be. Therefore, it would appear that the induction which would be manifested in a circuit composed entirely of an insulated conductor, would be the same as that in a circuit of twice the length, where one-half the circuit is completed by the earth, and the only difference which would exist between the one and the other would be, that in a circuit composed entirely of wire, the statical charge will be distributed more uniformly throughout the entire length.

But, says a writer on this subject, I admit that no advantage would result if two separate wires are are used, and which will, therefore, necessarily be some distance apart from one another, but place the two wires in the middle of a mass of gutta percha, and so close to each other that they may become virtually the centre of a system, and let the insulating material be of considerable sectional area, then no induction worth naming will take place between the wires and the earth, and the inductive influence of the positive wire will neutralise that of the negative wire.

The fallacy of the proposition will be at once seen if it be carried out more fully. Instead of letting the wires lie side by side, let the one wrap over the other, and be, in fact, a tube with a thin mass of insulating material between it and the inner wire. They will now become really the centre of the system, and fulfil completely the object desired by the author of this suggestion, but is it not evident that such an arrangement is the fac-simile of a Leyden jar, and will not the conditions be the most favourable that can be conceived for the development of induction?

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The only remedy which has been successful in mitigating the effects of induction, is that of throwing into the wire, immediately after a current has been sent, another of the opposite kind, this absorbs and neutralises the preceding wave much more quickly than when the is left to discharge itself in the ordinary way. This method, however, does not reduce the induction, but only mitigates its effects, although in circuits of moderate length its adoption has, for practical purposes, completely removed the inconveniences arising from the induced charge.

There are only two ways of reducing induction, the one is to increase the thickness of the insulating material, and so render the conditions less favourable for its development, and thus approach the conditions for a suspended circuit, where the induction having to take place through a considerable space of air—a dielectric of very low specific inductive capacity—there is but little accumulation of statical charge, and consequently the impetus is almost entirely directed forward, and scarcely diverted laterally to any appreciable extent.

In gutta percha covered wires, when the insulating material is increased in size, it has been shown that the full effect of the increased thickness is not obtained, owing to the outer surface increasing at the same time.

There is also another quality possessed by resinous substances, and probably by gutta percha, worthy of consideration. It is the property of absorbing a charge in the mass of the substance, instead of its being confined entirely to the surface; the tendency of this will be to still further reduce the advantage of an increased thickness of insulating material.

A reference to first principles will make this clearer.

All bodies insulate to a certain extent, and the only difference between a so-called conductor and insulator that would appear to exist, is a difference of degree, and if a charged body is brought into the neighbourhood of an insulated conductor, induction will take place through it in the same way as through a dielectric, but owing to the particles of conducting substances possessing the property of readily communicating their forces one to another, the inductive force developed at the further extremity will, within certain limits, be scarcely affected by the length of the conductor through which induction is taking place.

The absorption of a charge within the substance of the dielectric is an approach to this condition, but its practical moment when gutta percha is the insulating substance has to be determined by experiment.

Lessening the induction by reducing the resistance has next to be considered.

The first thing obviously will be to obtain a metal of the highest specific conducting power, for could the sectional area be diminished without increasing the resistance, the reduction would be reduced proportionately to decrease in the surface. The next will be to increase the sectional area of the conductor, and although this involves increased surface, yet there will be a gain; for when the diameter of a wire is enlarged, the surface over which the amount of induction extends does not increase in the same ratio as the sectional area which determines the resistance opposed by a conductor. To make this clearer, let four cables ranged side by side be employed as one conductor.

Such an arrangement will possess four times the sectional area, and oppose only one-fourth the resistance; in other words, the same tension of current will force through four times the dynamic quantity of electricity that would he generated through the single cable when used alone. Signals would not, however, be transmitted more rapidly through the four cables than through the one, for although the conducting power has been increased four times, the surface has been quadrupled also, which will exactly counterbalance the lessened resistance; but merge the four into one, the external inductive surface will then be halved, whilst the sectional area will remain the same as before, and there will be only half the induction manifested.

It therefore follows, when a wire is enlarged, that as the sectional area increases as the square, whilst the surface increases only in regular proportionals, the relative balance of forces in favour of rapidity of conduction will, in a submarine conductor of a given size, be twice the amount of that in a wire of half the diameter.

I would now attempt an explanation of how it happened, that an actual retardation was observed in some of the experiments with the Atlantic cable when a conductor of enlarged sectional area was employed; and on this head I would again quote from my remarks on a former occasion:—

"In the experiments to ascertain whether any advantage would result from the use of an increased sectional area of metallic conductor, recourse was had to joining the cables side by side, the increased inductive surface which such an arrangement involved having possibly been overlooked. This will account not only for an increased speed not having been obtained, but for an actual retardation having been noticed. Electromagnetic induction coils do not create electricity; they simply offer a ready means of converting electricity of low tension and considerable dynamic quantity, into electricity of very high tension and small dynamic quantity. The quantity evolved by them is always smaller in proportion as the intensity is greater. Both cannot readily be obtained together, and if a very high intensity is required, the quantity must be sacrificed, unless the size of the apparatus is immensely increased. This difficulty has evidently been appreciated, as the induction coils used by the Atlantic Telegraph Company are of large size and great length, so as to obtain high tension with an appreciable dynamic quantity. Nevertheless, there is little doubt but that the quantity evolved even by these machines, when compared with that generated from voltaic batteries, is small. This being the case, on giving the current a larger number of channels to rush into, there is not enough electricity to fill the wires, consequently the tension of the current will be very much lowered. The effect of this will be that a longer time will elapse before the tension of the wire will be raised sufficiently high at the further extremity to render itself apparent on the instrument. To obtain, under such conditions, the same speed with four cables as would be obtained with one alone, it would be necessary to employ four of these induction coils, ranged side by side, and worked with four times the battery surface, so as to generate four times the dynamic quantity of electricity. When qualified with these conditions, under which, no doubt, the experiments were tried, the reasoning contained in the Atlantic Telegraph Company's pamphlet, given in an earlier portion of this paper, is correct. It is precisely a case of having four Leyden arrangements to charge instead of one. A telegraph cable is, in fact, a Leyden arrangement, which has to be charged to a certain degree of saturation, before signals are obtained. The degree to which it has to be charged, statically, depends upon the extent of inductive surface compared to the conductibility of the metallic core. In a circuit where the conductibility of the metallic core is very great, compared with the inductive surface of the insulating material, no high degree of statical charge can take place, and signals will pass quickly. The opposite effect will be noticed in a circuit where the inductive surface is very large compared with the conductibility of the metallic core. The wire will then have to be statically charged very highly, before a perceptible current will flow from the further extremity, and signals will be obtained proportionately more slowly.*

The reason why signals are found to pass when magneto-electric induced currents are being employed in place of voltaic ones arises, I believe, not from any specific difference between them, but simply from the tension of the induced currents being very much greater than any voltaic ones which have been employed.

On this head I will say nothing further here, but would refer those who may take an interest in it to my paper of a former occasion, where I have fully entered into this subject, and also attempted an explanation of how it has happened that in the experiments with voltaic currents, of varying intensities, no difference of speed has as yet been observed.

The amount of retardation which will be experienced in submarine circuits possessing conductors of varying resistance, and insulated with different thicknesses of insulating material, it appears to me can, comparatively speaking, be readily determined by actual experiment.

I have for a long time been engaged in designing an apparatus for this purpose, and at the time I arranged to give the paper, I fully expected to have completed the apparatus, and to have been able to lay it before you on this occasion; and, though I regret not being able to do this, yet I feel I have sufficiently advanced to warrant my explaining the principles of its construction.

The principles upon which it is based are: that a body which offers the same resistance as another, without reference to its substance or length, may, as far as conducting power is concerned, be considered electrically the same. If we make use of a substance or metal of any inferior specific conducting capacity to that of the metal employed in submarine circuits, and also of greatly diminished sectional area, the same resistance as that offered by the very longest circuits can be obtained in a very small compass; and such an arrangement will, as far as simple conducting power is concerned, fairly represent a long submarine circuit.

The induction which manifests itself in submarine circuits can also be obtained if the conditions for its development are as favourable as they are in submarine conductors.

The apparatus consists—

1st. Of a series of resistances, the values of which are known.

2nd. Of a series of induction plates, the values of which, when compared with a given surface of a gutta percha coated wire are also known.

3rd. A mechanical arrangement to accurately measure minute periods of time.

By a combination of the resistances and the induction plates, a conductor, which will fairly represent a submarine circuit, will be obtained.

The resistance can be diminished or increased, and the inductive surface can be doubled or halved at pleasure, and thus circuits with conductors of varying lengths and sectional area, and different thicknesses of insulating material be imitated, and the law which governs the retardation in the transmission of telegraphic signals determined by direct experiment.

It may be argued that as the inductive surface in a telegraphic circuit is uniformly spread throughout, a series of induction plates will not present the same conditions, but it is evident that they may be divided throughout also, and although they will not then precisely represent what is actually the case, the result will approximate very closely to those obtained from a submarine conductor.

Perhaps it would have been prudent not to have called attention to an apparatus before its completion. I have done so, however, because I have

* *Vide*, "The Atlantic Telegraph."

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felt it was due from me to endeavour, at least, to point out how some of the important problems involved in submarine telegraphic communications between distant stations may be resolved.

The chief deductions from what has been brought forward in this paper are :—

1. That the metallic core of a submarine cable should be composed of a conductor of the highest specific conducting capacity.

2. That a decrease in the retardation which is caused by the induction that takes place in submarine circuits, can only be obtained by increasing the thickness of the insulating material, or increasing the size of the conductor, but that it will be better to do this by enlarging the sectional area of the conductor as much as is practicable.

In designing a cable there are many considerations besides those of its simple electrical qualifications which have to be entertained. The object to be obtained is the best result with the most economical investment of money. Are the proportions which were adopted in the Atlantic cable the best to ensure this?

The weight of the conducting coil in this cable is about 93lbs. to the mile, the value of which, speaking roughly, would, I suppose, be about as many shillings. When served with gutta percha its value was raised to £40 per mile. The iron sheathing and getting the cable on board brought its value up to £100 per mile. The expenditure, however, did not cease here; there was the hire of ships, salaries of staff, &c., &c. In this cable, therefore, only 5 per cent. at the outside was invested in the conductor upon which the transmission of the messages depended.

If the views which I have brought forward are correct, a conductor of double the diameter would only produce half the amount of retarding force of one of half the size. Such a conductor, at the very outside, would not cost more than £19 per mile, and the increased expenditure, in serving such a conductor with gutta percha, and giving it an iron sheathing, would not, comparatively speaking, be very large; the expenses of the staff and the hire of ships would be about the same in both cases; the latter would be, perhaps, increased slightly, but not to any material amount.

There are a great many other points which should be entertained in such a paper as this, but the paper has already run out to such a length that I will not trespass any further on your patience; and in conclusion I would only add, that if the ventilation of the subject, through the medium of this communication, should tend in any way to the progress of Electric Telegraphy, the object of its author which have been obtained.*

PRICES CURRENT OF INSULATING MATERIALS.

India rubber and gutta percha both very inactive; refer to last week's quotations.

September 25, 1862. WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic, A.	100	52 to 55	——
20	Do. B 7 per cent. till 1862 .	all	19 to 21	——
Stock	Electric Telegraph . .	100	100 to 103	——
5	London District Telegraph .	$4\frac{3}{4}$	$4\frac{1}{4}$ to $3\frac{3}{4}$ dis.	——
10	Mediterranean Extension Tel.	all	3 to 4	——
1	Submarine Telegraph, scrip.	all	$\frac{3}{8}$ to $\frac{5}{8}$	——
1	Do. registered . . .	all	$\frac{3}{8}$ to $\frac{5}{8}$	——
10	Do. " . . .	all	4 to 6	——
2	Telegraph to India . .	1	$\frac{5}{8}$ to $\frac{3}{8}$ dis.	——
5	United Kingdom Telegraph .	3	$\frac{1}{2}$ dis. to par.	——

Telegraphic News.

MR. ANDREWS, engineer and superintendent of the Mediterranean Extension Telegraph Company, and Mr. Gibson, inspector of telegraphs, left in the *Foxhound*, for Corfu, to test the Corfu end of the Otranto cable. The working of the telegraph to England continues to be most satisfactory. A telegram was received from Liverpool, a few days since, in two hours.

THE clerks in the Magnetic Telegraph Company's service having resolved to form a provident society amongst themselves, a meeting will be held in Manchester on Saturday next to further the object which has the support of all the principal officers.

* See excerpt minutes of Proceedings of the Institution of Civil Engineers, Vol. xvi., Session 1856-57.
See "The Atlantic Telegraph. A History of Preliminary Experimental Proceedings, &c., published by order of the Directors of the Company," pages 20, 23, 25, 26, and 40.
See also the *Engineer* of December and January, 1858-59.
"A discussion on the Induction in Submarine Circuits, by X. Y. Z., G. Blair, M.A., Telegraphic Engineer, and J. Tatlock.

A CORRESPONDENT, writing from Suez says "we are in daily expectations of hearing of the break-down of the Red Sea cable, if it breaks again it is not likely they will take the trouble to mend it, as it is in a very bad condition throughout."

"A telegram arrived this morning states, that 4000 Syrian Bedouins, well armed and mounted upon horses, had passed on their way to Suez. The same telegram mentioned that 2000 troops had left Cairo to intercept them if possible. Should a fight take place, and the Bedouins conquer, there is no doubt they will fall immediately upon Suez. There is great anxiety among the Europeans, every one looking at his gun or revolver and preparing in case of attack."

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

SIR,—In your number of the 5th inst. you give an account of the testing of sixteen miles of an india rubber covered conductor, recently manufactured into a cable by Mr. W. T. Henley, at his works at North Woolwich, in which the following appears: "The inductive discharge, upon sixteen miles, with two cells (of Daniell's) was 9°; with four cells 23°; and with six cells 45°."

Now as inductive discharge varies directly as the tension of the battery employed, that is to say, if a discharge from two cells give a deflection of 9°, then the discharge from four cells would be 18°, and from six cells 27°. It would therefore be very interesting to know how the gentleman who made the test, accounts for this great departure from a well known law.

ANTIMOMUS.

September 22, 1862.

To the Editor of THE ELECTRICIAN.

SIR,—During a short trip through the eastern counties, I chanced to take up a local paper of this week's date, and as I had no means of procuring anything to read at the village inn, at which I was temporaly resting, I thought I could while away the time by reading the article contributed by their "London Correspondent." We, of the *beau monde*, like to know what the rustics think of us.

"Oh wad the Gods the giftie gie us,
To see ourselves as ithers see us."

So sings the poet Burns; but imagine my dismay when I, who foolishly imagined that the rural population considered that London was the centre of perfection in arts, sciences, and everything that ministers to luxury and public convenience, imagine my humiliated feeling when I read, amongst other exposures of our mercantile system, that so simple a matter as the conduct of the mechanical part of our telegraph system, should be open to such strong animadversion as the following disclosure conveys. I quote the paragraph at length, with the hope that, through the medium of your widely circulated journal, directors of telegraph companies, and those specially interested in the subject, will take prompt measures to remedy such a flagrant system of mismanagement. I cannot suppose that any one, of whatever colossal proportions his scientific or mercantile position in society may be, can allow the week to pass without glancing over the pages of the ever vigilant *Punch*, yet, in case any over-studious man may have omitted seeing the "Electric Sparks" in this last week's number, I feel sure that telegraphic grievances will find expression in your columns, and possibly meet the eyes of persons most interested, who might fail to become aware of the defects of the system in any other way. I subjoin the paragraph in question :—

"I may be permitted, perhaps, to give such of your readers as are about to pay a visit to London, a word of advice with regard to sending messages to distant parts of this *little village* of ours. The very natural thought, where speed is required, is to telegraph. For instance, you want to send a rapid message from one part of London to its other extremity; you apply to the nearest district telegraph office, and fondly imagine that your important message will be there in no time. Far from it. You might have walked there yourself in less time, or a commissionaire would have taken it for you for a definite charge, and in a reasonable period. But the telegraph offices in London are a mistake and a sham. The clerks are bits of boys who can't spell, and the arrangements are altogether defective. We cannot, of course, expect telegraphs from anywhere to anywhere throughout the metropolis, and delay is partly a necessity; but at all events it is advisable that your readers should be informed that they should place no dependence upon it."

If the foregoing statement is to be accepted as the true statement of the experience of a London man, then the sooner the district telegraph offices are closed the better, as they only become the means of deluding two unfortunate classes of people, the directors, shareholders, and all persons looking for profitable investment of their money in electric telegraph speculations, and those who (having messages of the highest importance, on the correctness as well as swiftness of whose transmission, events involving life and death may possibly hang), are unwittingly made the victims of telegraphic official mismanagement, and the impudent caprices of half-educated, insolent, and overgrown lads. I should be sorry to condemn *all* the youths that are engaged in such respectable and responsible employ-

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ments as are open to them, in this department of mental labour; but I cannot help urging, as I have done in a former letter, the very great inexpediency, both as regards the moral as well as material interests and advantages of the young men of this generation; and I do hope that the strong agitation which is now taking place with respect to the employment of women, may be turned into this direction, as I have it on the authority of those well versed in the details of such matters, that females are especially adapted for such indoor employment, and I make no doubt that railway employées would make such arrangements amongst themselves, as would enable females of the most sensitive and correct character to undertake the duties of the offices without any risk of impertinence or impropriety occurring.—I am, sir, yours respectfully,

September 23, 1862. PHILANTHROPOS.

IMPORTANT ERROR.

SIR,—In "Chambers', Arithmetic" (Educational Course), page 8, it is stated that—

1,000 million = 1 billion
1,000 billion = 1 trillion.
1,000 trillion = 1 quadrillion.

This is the French mode of reckoning, but not the English, in which 1,000,000 millions = 1 billion, a million million of millions = 1 trillion; in other words—

If M = a million.
M^2 = a billion.
M^3 = a trillion.
M^4 = a quadrillion.
M^7 = a septillion.
M^{10} = a decillion.

These great figures are chiefly useful in astronomy, and our clear English system should be kept distinct from the French one, in which a trillion is only equal to our billion, and a quintillion to our trillion.

The French divide all circles into 400°, we into 360°. These facts should be generally known.—I am, dear sir, yours truly, FACT.

September 10*th*, 1862.

Miscellanea.

SEAMLESS COPPER TUBES.—Some of the seamless tubes made ostensibly from copper, appear to be formed of an alloy. This is the more probable because copper cannot readily be cast into the hollow ingots from which the tubes are to be drawn. Pure copper, in its melted state, has a pudding-like consistency, and when cast is likely to come out unsound. In alloying it, to increase its fluidity when melted, the metal is not only debased, but it loses much of its malleability. At a seamless tube works, near New York, pure copper is cast into sound tubular ingots by running the fluid metal into moulds revolving some 2000 turns a minute. The centrifugal force thus imparted to the metal condenses it upon the inner surface of the mould, and experience in the use of the tubes thus cast, shows that perfect soundness is thereby attained. The refining furnace is set up close by the moulds, of which there are twenty, more or less, disposed radially around a central shaft, the axis of each mould lying horizontally. A large friction wheel on an upright shaft gives motion to all the moulds. A measured quantity of metal from the furnace is poured successively into the end of each mould, the result being a tubular ingot, of say 1 ft. in length, 4½ in. in diameter, and having a beautiful smooth cylindrical hole, of about 3 in. bore throughout its length. When cold this ingot is heated and rolled upon a loose mandril, between four rollers so disposed as to embrace its entire circumference. After being thus rolled out to a length of 2 ft., the process is repeated until the length is increased to 3 ft. or 4 ft. After annealing it, it is then drawn successively through dies of gradually diminishing size until the tube has been brought to the required diameter and length. A single pass through a smoothing die completes the process.—*Engineer.*

THE large martello tower which guarded the entrance to Chatham harbour, has been entirely demolished, the removal of the fort having been rendered necessary by the enlargement and extension of Chatham dockyard, one of the proposed new basins occupying the site on which the tower formerly stood. For several weeks past a number of the sappers and miners of the Royal Engineers, acting under the direction of Colonel Lovell, C.B., the principal director of field works at the Royal Engineer establishment, have been employed in driving the galleries in order to remove the tower by heavy charges of gunpowder. The charges of powder used on the occasion were each of 40 lbs. weight, distributed at equal distances beneath the foundations, the whole being connected by wires. The explosion was under the immediate direction of Captain Scott, the head of the electrical department at the Royal Engineer establishment. At a given signal the electric spark was sent through the wires, and in an instant after the base of the tower was seen to force itself outwards, followed by the entire structure rising bodily in the air, and descending in a shower of stones, bricks, and mortar, the effect being exceedingly grand.

USEFUL ALLOYS.—Lensson gives (*Journ. für prakt. Chemie, bd,* lxxxv. s. 98) the composition of an alloy which is used in some calico printworks at Mülhausen. It consisted of bismuth 10·15, tin 57·23, lead 31·15. The pattern is first cut in wood as a matrix and is then impressed on the alloy. Clemens Winkler says (*Deutsche Industrie Zeitung*, 1862, No. 12) that a good alloy to replace brass for taps, is made by melting together two parts copper, one part nickel, and one part tin. The product is slightly ductile, in colour resembles steel, and is very hard. It takes a beautiful polish, and is not acted on either by air or sulphuretted hydrogen. This alloy gives also a fine tone when struck, and may be used for bell metal.

NEW GUN METAL.—The cannons newly cast in Austria for the marine service, and from which so much is expected, are formed from a new alloy called Aich metal, from the name of the inventor. It is composed of copper, 600 parts; zinc 382; iron 18. Its tenacity is said to be excessive; it is easily forged and bored; when cold it may be bent considerably without breaking; its resistance is far greater than that of iron of the best quality. This announcement makes us earnestly wish to learn the fate of the cannon of aluminium bronze, which M. Christolphe cast at his own expense, and which was so severely tried at Vincennes.—*Cosmos.*

AN *on dit* is in circulation to the effect that Mr. Nathan, whose lectures on electricity have obtained him a just repute, was lately delivering a discourse at a mechanic's institute, and having passed a severe current of electricity into a pail of water, he challenged anyone to remove a sum of money placed therein. Several attempts were tried, but without success, when Mr. N. triumphantly placed the whole proceeds of the lecture, said to amount to nearly £15, and again repeated his challenge. Again did the yokels essay, and time after time they retired in dismay, when one as bold as the rest came forward, dipped his hand in and bore the prize away. *He had gutta percha soles!* It is scarcely necessary to add that he (and the lecturer) at once "skedaddled."

HAVING already remarked that electricity travels at the speed of 288,000 miles in a second of time, it is, of course, immaterial to what distance these line wires are carried, or how far away the corresponding instrument may be; the effect is instantaneous, and the current of electricity passing through the distant coils, at an inappreciable difference of time, causes our own needle, and that of our correspondent, to be moved in the same direction, and at exactly the same moment. The flow of electricity is stopped directly the handle is brought to a perpendicular position. With this result the current of electricity has performed the duty required of it; but, as before stated, it is necessary either to complete the circuit, or find an outlet for it; this may be done either by providing an additional line wire, or, better still, and far more economically, by conducting it into the earth as so much waste electricity. The alphabet is indicated by the movements of the needles, thus:—the left hand needle moved once to the left signifies the "stop," this is given at the end of every word, and likewise means "not understand;" two movements to the left for the letter A, three B; once to the right and then to the left C, the reverse way D, once to the right E, twice F, three times G; the signal E also indicates the signal "understand." The next eight letters are made with the right hand needle in the same way. Once to the left H, twice I, three times K, right and left L, the reverse way M, once to the right N, twice O, thrice P. The remainder of the letters are made by the combined movements of both needles. Both pointing to the top, or to the letters E H for for Q; both to the bottom and left hand R, twice S, three times T, right and left U; the reverse way V; once to the right W, twice X, three times Y, and the reverse of Q for Z. Having in this way obtained a signal for every letter of the alphabet, it will be easily understood that words are spelt, at full length, letter by letter, the combined movements forming the word complete. All figures are likewise spelt in full, and every word is acknowledged by the signal E (understand), or by "stop" (not understand). In the latter case the word is repeated until the signal E is given, and the clerk who receives it writes it down before another word is proceeded with; this is done by experienced clerks at the rate of from 15 to to 20 words a minute. At one time it was customary to ring a bell, by the agency of the voltaic current, as a preparatory signal whereby to call the attention of the distant operator. But it was found that the clerks relied too implicitly on the bells, and that serious delays occurred through inattention, whenever they became disordered, which was frequently the case. Bells are, therefore, seldom used, at the present time, in connection with needle telegraphs.—*Dodwell's Handbook to the Electric Telegraph.*

To Correspondents.

E. KERNAN.—We believe that the description of Siemen's induction coil, which was quoted in our issue of 8th August, is to be depended upon. We shall be glad to hear of the results obtained with the coils you mention. If you are in possession of the facts relating to the original invention of the induction coil, and can communicate the same, we shall be glad to place them, as a matter of history, before our readers.

C. P. The experimental tests connected with the Malta and Alexandria cable were conducted in privacy, and in a foreign language. The fallacy of such experiments may be easily detected by the application of the laws of temperature which govern the insulating capacity of gutta percha. We trust that future telegraphy will be spared the humiliation of undergoing such tests.

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The Electrician.

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CONTENTS:

	PAGE		PAGE
Meeting of the British Association ...	253	The Galvanic Circuit Investigated Mathematically	258
The Chemical Theory of the Voltaic Couple	253	M. Robin's Soirees	259
On the Influence of Electricity upon Vegetation	254	The Correlation of Physical Forces ...	260
Exhibition Awards	256	Prices Current of Insulating Materials	262
Discovery of the Art of Electro-Deposition of Metals	255	Telegraph Shares	262
Increased Efficiency of Lightning Conductors	258	Atmospheric Electricity	262
		Correspondence	262
		Miscellanea	264
		To Correspondents	264

MEETING OF THE BRITISH ASSOCIATION.

ONE of the most interesting questions, both in a practical and theoretical point of view, affecting the applications of electricity will again be brought before our readers, at the approaching meeting of the British Association, at Cambridge, through the Report of the Committee appointed to recommend for practical adoption certain determinate units of electrical measurement. For the want of such units, it has been hitherto almost impossible to ensure the repetition of any experiment or operation in electricity under precisely the original conditions. We do not anticipate that the question will yet receive a definitive solution, as it is one presenting no small practical difficulty, and as, moreover, it is indispensable that the units which may be suggested should generally receive the approval both of practical telegraphists and of theoretical electricians. A unit which would satisfy the latter, and which might even be received by the former as an abstraction based upon the most carefully verified scientific principles, would not necessarily, on that account, meet the requirements of practice, and render valuable service in the operations of telegraphy.

Much has latterly been done to perfect the principle and construction of instruments, mostly upon the system of WHEATSTONE's bridge, for the measurement of telegraphic resistances, and for determining the position of "faults." Several of these will be exhibited and explained at the Cambridge meeting.

We look forward to the publication of some novel and interesting facts relative to thermo-electricity, a subject which also engaged some attention at the Manchester meeting last year. The importance of thermo-electricity, as a branch of electrical research, is every day increasing; and it appears probable that it may ultimately give valuable results in the applications of electrical agencies.

We presume that some reference will be made, in the Chemical Section of the Association, to the late experiments of KARSTEN, upon the oxidation of hydro-carbon compounds. It has been found that these compounds are invariably liable to a slow oxidation in air, with production of carbonic acid and water. The same action takes place in water containing air. In water deprived of air, the hydro-carbons are protected from oxidation; but after the lapse of a considerable period, exhibit a tendency to decomposition. It is probable that this effect might be almost indefinitely postponed through the catalytic action of various substances which are known as powerful antiseptics. In relation to gutta percha and caoutchouc, as employed in telegraphy, these facts are full of interest, and point very obviously to the necessity of further research upon the chemical properties of these insulating materials.

Another question of the day, in more intimate relation to electric science, is the application of the induction coil to an electric lamp for miners. The apparatus for this purpose, contrived by MM. DUMAS and BENOIT, consists of a small voltaic battery, a coil similar in construction to that of RUHMKORFF, and one of GEISSLER's vacuum tubes. By means of these is produced a light sufficient to enable the miner to work with safety, in an atmosphere strongly impregnated with fire-damp, and in which the Davy lamp would become extinguished. Its superiority over the latter consists, however, in the fact that it is, under all circumstances, completely inaccessible to the explosive mixture, that the light is not obscured by any external casing of wire gauze, that it may instantaneously be lit or extinguished at pleasure, and that it will act for at least twelve consecutive hours without any particular attention.

THE CHEMICAL THEORY OF THE VOLTAIC COUPLE.

THE chemical, or rather the electro-chemical, theory of voltaic action, forms a very necessary introduction to the mathematical investigation of the different causes which influence the quantity of electricity traversing a voltaic circuit, and is especially of value in any question relating to the construction, or action, of new voltaic combinations. As there are several of these which may deserve our consideration, it will, perhaps, be useful briefly to resume some of the main facts of this theory, as commonly received, and to present for discussion some points which cannot be considered as definitively settled.

In relation to each other, the chemical elements, and most of their compounds, are said to be electro-positive and electro-negative, according as they appear at the negative or positive pole of the battery during electrolysis. Reacted upon by the electrical attractions which determine chemical affinity, the positive constituent of a compound appears at the negative pole, and the negative constituent at the positive pole. It appears to be assumed, and with some degree of reason, that an electro-positive body is constructed with a greater proportion of electricity than exists in the substances which are electro-negative to it.

The operation of the chemical affinities due to the *constituent* electricity of bodies, may be counteracted by an electrical charge of an opposite nature, and of a tension proportionate to the affinity to be overcome. Thus, if a plate of pure zinc be attached to the negative pole of a battery, of which the positive pole is connected to earth, the metal may be immersed in dilute sulphuric acid without being chemically acted upon. Or, if the positive pole of the battery be brought into efficient contact with the acid, the zinc, instead of entering into combination with the electro-negative oxygen of the fluid, may evolve from its surface the electro-positive hydrogen. The proposition is, perhaps, best exemplified by connecting together by their opposite poles two voltaic couples of similar nature, by which means the positive metals, if pure, or homogeneous on their surface, will be almost absolutely protected from chemical action.

In similar manner, the attraction, or affinity, of an electro-positive for an electro-negative, is counteracted in an insulated single couple, while the circuit remains incomplete. The electro-positive zinc is acted upon only to a sufficient extent to produce and maintain in it a condition of negative tension, while, by the same action, the fluid acquires a positive tension. If the fluid be now connected to earth, its positive tension becomes neutralized, and the zinc is again acted upon, imperceptibly, but to a sufficient extent to double its negative tension, and thus to render it indifferent to the electro-negative fluid when deprived of its counteracting electrical charge.

The negative element of the couple, the action of which is merely to conduct the positive electricity from the fluid, obtains the same degree of tension as the latter, *provided* it be not acted upon in any degree by such fluid, and its surface be maintained clear from electro-positive bodies,—such as the film of hydrogen produced by polarization and decomposition of the fluid, reduced zinc, &c.

It follows from the above, that the electro-motive force of a couple, or the difference of tensions at the poles, is, in all cases, directly as the affinity of the positive element of the battery for the electro-negative constituent, or *anion*, of the exciting fluid or electrolyte, and inversely as the affinity of the negative element

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for the anion. Assuming that the negative element manifests no affinity for the anion of the electrolyte, and, consequently, assumes the same tension as the fluid, and that the surface of this element preserves its normal condition, then, in all cases where the voltaic action is produced by the oxidation of the metal zinc, the electro-motive force will be the same.

That this proposition is not universally recognized, is shown by the fact, that several experimenters have endeavoured, by modifying the constitution of the exciting fluid, to increase the *tension* in couples with zinc positives beyond the limits which prevail when a fragment of zinc is plunged into pure water. Again, it is commonly supposed that the tensions in a "water-battery," of zinc-copper, for instance, are necessarily higher than those in a battery composed of an equal number of couples of Wollaston or Daniell.

A necessary function of the exciting fluid is to *maintain* the initial tensions of the voltaic elements; but, unless the originating chemical action be essentially changed, it cannot increase these tensions. By opposing the *minimum* amount of resistance to decomposition, and, consequently, to conduction, we may, however, by the employment of certain electrolytes, greatly increase the quantity of electricity set in motion by a couple immersed in water, through a wire of small or moderate resistance. For this purpose the affinity in the electrolyte of the anion for the cation should be inconsiderable.

This affinity is greatly reduced, when, to the water employed as an exciting fluid, we add sulphuric acid. In this case the acid exerts a catalytic action; without itself becoming decomposed, it decreases the affinity of the constituents of water, oxygen and hydrogen. It also removes the oxide which is formed on the surface of the positive element, thus producing a sulphate of the metal zinc.

The tension of the elements immersed in the acid fluid is found, however, after a certain period, to have become considerably reduced, and, apparently, also, the *resistance* of the fluid becomes augmented. The reason of this appears to be that a portion of the hydrogen liberated at the surface of the negative element, instead of being evolved, adheres to this element, not only impeding the passage of the current, but, in its capacity of *electro-positive*, *polarising* the plate, decomposing the electrolyte, and producing a current which tends to pass in the opposite direction to that generated by the oxidation of the zinc.

(*To be continued.*)

ON THE INFLUENCE OF ELECTRICITY UPON VEGETATION.

A correspondent, under the initials "C. M. B.," latterly gave some details of an experiment, in which some growing plants, insulated from the earth, were submitted to electrical action by connecting them with the positive conductor of an ordinary plate machine. The following accounts of similar experiments, quoted from Sturgeon's "Annals of Electricity," are of considerable interest in regard to a question which has hitherto received but little investigation. In addition to the fact that different portions of plants are constantly in a condition of opposite electrical tensions, it is known that electricity must continually be conducted from the atmosphere by the multitude of acute points presented by the vegetation on the surface of the earth. It is scarcely to be doubted, but that the passage of electricity through the more or less delicate structure of the plant, is attended with important results in the vegetable economy. In one point of view, the *flora* of the globe appears as an immense apparatus for the purpose of silently effecting the neutralization of atmospheric electricity. The "attractive influence" of vegetable points is very remarkable. If we present to the prime conductor of an electrical machine, the finest metallic point and a blade of grass, keeping them equi-distant from the charged surface, we find that the vegetable point continues to be illuminated at several times the distance at which the metal ceases to exhibit any light. Hence, the myriad conductors of lightning, wherever vegetation exists, must constantly give rise to a dynamic effect, taking place through the fluids and fibres of plants.

"On the 28th of April," says Mr. Thomas Pyne, writing for the publication we have mentioned, "I sowed mustard seed in similar soils, contained in two jars, one electrified positively, the other negatively. The covers being removed, they were both left open to the action of the atmosphere. In four days the plants appeared in both jars, but those in the negative jar were the most advanced; while no plants appeared till about two days later from a similar sowing at the same time, unelectrified. On the 12th of May, the plants in the negative jar had grown to 2¾ inches, those in the positive jar to 2¼ inches, in height; those unelectrified, or rather, remaining in the ordinary state, to 1⅛ inch. The electrified plants were vigorous and flourishing in proportion to their height. This result in favour of the plants negatively electrified, must have arisen chiefly from the *relative* superiority of electric matter in the atmosphere; in the case of those positively electrified, the absolute quantity was increased, but the relative difference between those and the atmosphere somewhat reversed. Hence, it appears, that while much depends on electric influence, its positive state in the atmosphere, as contrasted with the soil, operates most effectually on vegetation. The difference of more than half in height in favour of the former, above those in the natural state, strongly encourages the conclusion, that the constant accessions of electric fluid in the atmosphere at the spring of vegetation, constitutes its influence, and that on the degrees of that influence depend, in a great measure, the rapidity and vigour of its rise and progress. A medical electrician, residing in this town, acquainted me with the following particulars:—A narcissus plant, when in a very weak and languishing state, was placed in a room in which his powerful machine was kept in frequent action, and soon began to show signs of extraordinary vigour; it grew to the height of 36 inches, and was stout and luxuriant in proportion. Some branches of the moss rose, and various other flowers in the room, retained their colours while the seeds were forming, during about five weeks, and at length dropped off without losing their freshness. These, and some other particulars which he related to me, on the correctness of which I have reason to rely, show the vast advantages that might be expected to result from a continued powerful electricity in the atmosphere, accompanied with a suitable temperature and dryness. If a plant can be made to expand to thrice its ordinary dimensions, by an artificial exercise of positive electricity, and that in a confined situation, where the direct rays of the sun could hardly exert their ordinary influence, how important must be the operation of this principle, in proportion, as it would seem, to the degrees in which it obtains."

The following is from the pen of Mr. W. H. Weekes, of Sandwich:—"The vast superiority of vegetable over metallic points, in drawing off and accumulating electric matter, is, I conceive, a subject of great interest and importance. A coated jar, having 46 inches of metallic surface, was repeatedly discharged, by the activity of a vegetable point, in 4 min. 6 sec.; while the same jar, charged to the same degree, required 11 min. 18 sec. to free it from its electric contents by means of a metallic point; the points in both cases being equidistant. I find, also, that Bennett's gold leaf electroscope (a delicate instrument) is powerfully affected by a charged jar, at the distance of nearly 7 feet, when the brass cap of the instrument is furnished with a branch of the shrub called *butchers' broom*, which I have found of great use in my experiments. The same instrument, when mounted with pointed metallic wires, is not perceptibly affected until the charged jar approaches to within 2 feet of the cap."

The above reminds us of an incident which has once or twice fallen under our notice, in experimenting with the Peltier electrometer. The instrument, apparently in perfect order, has been found incapable of retaining a charge. The surface of the insulating compound was carefully cleaned and warmed, and the ordinary restorative methods adopted, without effect. At length, an almost microscopic fibre of cotton has been found lodged in a portion of the brass-work, where the brass knob of the instrument is made to screw on. This being removed, the efficiency of the electrometer was restored.

Mr. Weekes describes an apparatus for obtaining indications of atmospheric electricity, by means of a small branch of the butchers' broom fixed by a twine to the upper extremity of a wire connected to an electrometer. This apparatus was affected inductively by clouds passing at a great altitude, and under circumstances in which electrometers with metallic points gave no indications. The following details of an experiment similar to the foregoing are also given:—"The correctness of your opinion (that of Mr. Pyne) respecting the influence of electricity upon the growth of plants, appears to me to be sufficiently proved by the following experiments. Two small flower-pots, filled with rich mould, were taken for the purpose in-doors. A few grains of mustard seed were sown in each; both were kept gently watered, but one pot was insulated, and frequently electrified

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under circumstances which kept it, as it were, in an electrical atmosphere. The other pot had no such attention paid to it, and the result proved what you probably would anticipate. The vegetation of the electrified seeds appeared several days before the others, and continued afterwards to grow with a much greater degree of vigour. As a lover of science, you can easily imagine the pleasure these pursuits have yielded, and to this has succeeded an anxious desire that you should speedily assert your claims, or I apprehend you will lose your just title to originality."

We commend the above to the attention of horticulturists, as well as to the electrical student who may desire to enter upon a comparatively new field of investigation.

The following experiment, from Mr. Williams's "Climate of Great Britain," was designed to show the presence of an electrical atmosphere, around the surface of vapour as it condenses by cooling, and that the electricity is attracted and absorbed by the leaves of plants. "To the cap of a gold-leaf electroscope, I affixed a horizontal support for a candle, which projected two feet from the cap of the instrument placed near the edge of a table; on the floor, immediately below, was an earthen vessel, containing hot water about one inch in depth; the candle being lighted, two or three red hot embers were dropped into the vessel of water, which instantly raised a sudden cloud of vapour; the electricity of this being collected by the candle connected with the electroscope, the gold leaf opened suddenly, and struck the sides positively. Some branches of trees with their foliage were now placed between the vessel on the floor and the candle; the experiment being repeated, the vapour passed through the interstices of the boughs, but the electroscope opened only half an inch; more boughs were now added, and slightly sprinkled with water to increase their conducting power; the experiment was again repeated; a great part of the vapour still made its way through the interstices of the leaves and branches, but so completely deprived of its electricity that the gold leaf did not diverge in the smallest degree."

EXHIBITION AWARDS.

Had it been expedient or practicable to distinguish between actual producers and mere salesmen in an exhibition of competitive industry, it is plain that a higher principle would have governed the awards which the juries conferred on exhibitors. That such a system of discrimination was not expedient and was not practicable, we suppose to be a fact beyond disproof, and one which affords sound argument against any bestowal of medals or prizes whatever. The man who sells the best wares will obtain most custom and celebrity. He deserves well of the public, who are sure to requite his merits; but it is absurd to offer him an honorary testimonial for good tradesmanship, which is a quality certain to bring its own natural and fitting reward. We may perhaps, step out of the beaten track of political economy to honour a man whose originative thought and skill have helped in any way to increase the resources of civilisation; but it is not of such men that the catalogue of contributors to a great manufactural display can in great part consist. Commercial enterprise is the main element of success in such undertakings as the International Exhibition; and it is precisely this element which, as me have endeavoured to show, is most opposed to a system of prize-giving. We are aware that an attempt was made, in the Paris Exhibition, to carry out the principle of recognising manufacturers only, in the distribution of awards; but the plan was notoriously found to be impracticable, and we could bring forward scores of instances where medals were given to exhibitors who never employed a single workman. The department which we are about to notice is one that, more than any, demands a careful separation from its manufactural and its commercial phrases. To treat a chronometer-dealer as a chronometer maker, and to commend him for the excellence of the goods that he exhibits, without questioning whether they were produced under his eye, or imported by him in the way of simple merchandise, is an act too futile to need that exposure which, in all likelihood attend the forth-coming expression of opinion, elicited from jurors and leading exhibitors, by the Council of the Society of Arts. We are desirous, in our remarks on the horology of the International Exhibition, to give due credit, first to invention, and next to that enterprise which employs and brings to perfection the best manipulative skill. With the question of jurors' awards, in Class 15, we shall trouble our readers but little. The radically vicious principle which pervades all departments of the Exhibition, in respect to the distribution of medals, was not likely to be modified in practice by the jury of this particular class. We will impute no unworthy motives to individuals, but we cannot avoid the conclusion that impartiality has been less possible in the horological than in most other classes represented. One juror, who makes watches for an exhibitor next to whose case of specimens is placed his own, with a single attendant between them, virtually assists to give a medal to himself; for though, being on the jury, he is excluded from receiving an award, the distinction is conferred on the vendor of his manufactures. A single instance such as this, speaks the entire condemnation of the system; and yet, so far from its being a solitary example, there are many such in the International Exhibition.—*Daily Telegraph.*

DISCOVERY OF THE ART OF ELECTRO-DEPOSITION OF METALS.

The following paper, giving an account of the original experiments which led to some of the most important industrial applications of electricity, is chiefly interesting in a historical point of view, but may also be most instructive and encouraging to those who are commencing the study of electrical manipulation. We say encouraging, for Mr. Thomas Spencer, whose name is entitled to rank among the foremost of those which have been rendered illustrious by discovery in the important branch of physical science to which our efforts are specially directed, was an amateur student "of no scientific reputation," and quite unknown to those who assumed the duty of encouraging scientific investigation. Although others had previously noticed the deposit of copper which takes place upon the negative element of Daniell's couple, as indeed they could not fail to do in experimenting with the battery, the priority of the discovery of electrotyping, *as an art*, belongs to Mr. Spencer. It should be stated, however, that previously to the *publication* of the discovery in England, Professor Jacobi of St. Petersburg, was engaged in experiments on the electro-deposition of copper, and had, in fact, independently arrived at many of the results obtained by Mr. Spencer. The paper we now quote was originally written for the meeting of the British Association *for the promotion* of Science, at Birmingham, in the year 1839. We are tempted to give Mr. Spencer's own account of his reception by the representatives of that body:—

I was shown to a Mr. Carpmael. After intimating my business, I inquired when I should be called on, that I might be in readiness. I was told that a note had already been made of it, and to hold myself in readiness on Thursday morning, as my paper would be called on first. With this I was perfectly satisfied; but on Wednesday, when the papers for the following day, as is usual, were announced, I could not find my name or paper in the list. I at once addressed a note to the secretary, thinking he had forgotten our previous arrangement, and reminding him of it. I attended next morning at the appointed time, prepared, if called on; but on entering the committee-room, I was informed by Mr. Carpmael that my paper could not be brought forward, giving, as a reason, that "I was quite unknown." On asking what this meant, I was told that I was a man of no scientific reputation, and more especially unknown to himself and the acting president of the section, Dr. Lardner; also, that there were so many important papers to be brought forward by men of acknowledged reputation, that there was no chance for me.

When the section has closed its labours for the day, seeing Dr. Lardner in the room, I mentioned to him, as president of the section, the arrangements that had been entered into with me by the secretary respecting my paper. Before he heard more than a few words, he told me had nothing whatever to do with it, and haughtily turned away, adding something about valuable time.

Under these circumstances, I could not bring forward the paper: but, had it not been for the unavoidable absence of Professor Phillips, I am quite sure the engagements entered into with me would have been kept.

Such was the encouragement given to the inventor of the electrotype.

It may be mentioned that Mr. Spencer, who does not appear subsequently to have greatly obtruded himself on the notice of scientific societies or associations, is the discoverer of the method of giving a conducting surface, by means of plumbago, to non-metallic bodies for the purpose of coating the same with metals.

AN ACCOUNT OF SOME EXPERIMENTS MADE FOR THE PURPOSE OF ASCERTAINING HOW FAR VOLTAIC ELECTRICITY MAY BE USEFULLY APPLIED TO THE PURPOSE OF WORKING IN METAL.

BY MR. THOMAS SPENCER.

In the paper I have now the honour to lay before the Society,* I do not profess to have brought forward a perfect invention. My only object is to point out a means by which, I hope, practical men may untimately be enabled to apply a great and universal principle of nature to the useful and ornamental purposes of life. In this I may be considered sanguine—an error, I am aware, too often fallen into by those, who, like myself, imagine they have discovered an useful application of an important prin-

* The Liverpool Polytechnic Society.

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ciple; but however this may fall out, I now proceed to lay an account of its results, successful and unsuccessful, before the members and the public—previously stating, however, that all my first experiments were made on a small scale; a method of procedure attended with many advantages to the experimentalist himself, but having its disadvantage when laid before the public. In this first respect, the chemical experimenter has a decided advantage over the mechanical one; the success of his experiment, when tried on a small scale, doubly guarantees its success, if conducted on a still larger—with mechanical results I believe in most instances it is the reverse. But, when the chemist produces his microscopic proofs, the public are generally slow to believe that such minute appearances should warrant him in coming to any general conclusion.

In September, 1837, I was induced to try some experiments in electro-chemistry, with a single pair of plates, consisting of a small piece of zinc and an equal sized piece of copper, connected together with a wire of the latter metal. It was intended that the action should be slow; the fluids in which the metallic electrodes were immersed were in consequence separated by a thick disc of plaster of paris. In one of the cells was sulphate of copper in solution, in the other a weak solution of common salt. I need scarcely add that the copper electrode was placed in the cupreous solution. I mention this experiment, briefly—not because it is *directly* connected with what I shall have to lay before the Society, but because, by a portion of its results, I was induced to come to the conclusions I have done in the following paper. I was desirous that no action should take place on the wire by which the electrodes were held together. To obtain this object I varnished it with sealing-wax varnish; but, in so doing, I dropped a portion of it on the copper that was attached. I thought nothing of this circumstance at the moment, but put the experiment in action.

The operation was conducted in a glass vessel; I had, consequently, an opportunity of occasionally examining its progress. When, after the lapse of a few days, metallic crystals had covered the copper electrode, with the exception of that portion which had been spotted with the drops of varnish, I at once saw that I had it in my power to guide the metallic deposition in any shape or form I chose, by a corresponding application of varnish, or other non-metallic substance.

I had been long aware of what every one who uses a sustaining galvanic battery with sulphate of copper in solution must know, that the copper plates acquire a coating of copper from the action of the battery; but I had never thought of applying it to a useful purpose before. My first essay was with a piece of thin copper plate, having about four inches of superfices, with an equal sized piece of zinc, connected together with a piece of copper wire. I gave the copper a coating of soft cement, consisting of bee's-wax, resin, and a red earth—Indian or Calcutta red. The cement was compounded after the manner recommended by Dr. Faraday, in his work on chemical manipulation; but with a larger proportion of wax. The plate received its coating while hot. On cooling, I scratched the initials of my own name rudely on the plate, taking special care that the cement was quite removed from the scratches, that the copper might be thoroughly exposed. This was put in action, in a cylindrical glass vessel, about half filled with a saturated solution of sulphate of copper. I then took a common gas glass, similar to that used to envelop an Argand burner, and filled one end of it with plaster of paris, to the depth of three quarters of an inch. In this I put some water, adding a few crystals of sulphate of soda to excite action, the plaster of paris serving as a partition to separate the fluids, but sufficiently porous to allow the electro-chemical fluid to permeate its substance.

I now bent the wires in such a form that the zinc end of the arrangement should be in the saline solution, while the copper end should be in the cupreous one. The gas glass, with the wire, was then placed in the vessel containing the sulphate of copper.

It was then suffered to remain, and in a few hours I perceived that action had commenced, and that the portion of the copper rendered bare by the scratches was coated with the pure bright deposited metal, whilst all the surrounding portions were not at all acted on. I now saw my former observations realised; but whether the deposition so formed would retain its hold on the plate, and whether it would be of sufficient solidity or strength to bear working if applied to a useful purpose, became questions which I now endeavoured to solve by experiment.

It also became a question whether—should I be successful in these two points—I should be able to produce lines sufficiently in relief to print from. This latter appeared to depend entirely on the nature of the cement or etching-ground I might use.

This last I endeavoured to solve at once. And (I may state) this appeared to be the principal difficulty; as my own impression then was, that little less than one-eighth of an inch of relief would be requisite.

I then took a piece of copper, and gave it a coating of a modification of the cement I have already mentioned, to about one-eighth of an inch in thickness; and, with a steel point, endeavoured to draw lines in the form of net-work, that should entirely penetrate the cement, and leave the surface of the copper exposed. But in this I experienced much difficulty, from the thickness I deemed it necessary to use; more especially, when I came to draw the cross lines of the net-work. When the cement was soft, the lines were pushed, as it were, into each other; and when it was made of harder texture, the intervening squares of the net-work chipped off the surface of the metallic plate. However, those that remained perfect I put in action as before.

In the progress of this experiment, I discovered that the solidity of the metallic deposition depended entirely on the weakness or intensity of the electro-chemical action, which I found I had in my power to regulate at pleasure, by the thickness of the intervening wall of plaster of paris, and by the coarseness and fineness of the material. I made three similar experiments, altering the texture and thickness of the plaster each time, by which I ascertained that if the plaster partitions were *thin* and *coarse*, the metallic deposition proceeded with great *rapidity*, but the crystals were friable and easily separated; on the other hand, if I made the partition thicker, and of a little finer material, the action was much slower, and the metallic deposition was as solid and ductile as copper formed by the usual methods; indeed, when the action was exceedingly slow, I have had a metallic deposition apparently much harder than common sheet copper, but more brittle.

There was one most important (and, to me, discouraging), circumstance, attending these experiments, which was, that when I heated the plates, to get off the covering of cement, the meshes of copper net-work invariably came off with it. I at one time imagined this difficulty insuperable, as it appeared to me that I had cleared the cement entirely from the surface of the copper I meant to have exposed; but that there was a difference in the molecular arrangement of copper prepared by heat, and that prepared by voltaic action, which prevented their chemical combination. However, I then determined, should this prove so, to turn it to account in another manner, which I shall relate in the second portion of this paper.

I then occupied myself for a considerable period in making experiments on this latter section of the subject.

In one of them I found, on examination, a portion of the copper deposition, which I had been forming on the surface of a coin, adhered so strongly that I was quite unable to get it off; indeed, a chemical combination had apparently taken place. This was only in one or two spots, on the prominent parts of the coin. I immediately recollected that on the day I put the experiment in action, I had been using nitric acid, for another purpose, on the table I was operating on, and that, in all probability, the coin might have been laid down where a few drops of the acid had accidentally fallen. I then took a piece of copper, coated it with cement, made a few scratches on its surface, until the copper appeared, and immersed it for a short time in dilute nitric acid, until I perceived, by an elimination of nitrous gas, that the exposed portions were acted upon sufficiently to be slightly corroded. I then washed the copper in water, and put it in action as before described. In forty-eight hours I examined it, and found the lines were entirely filled with copper. I applied heat, and then spirits of turpentine, to get off the cement; and, to my satisfaction, I found that the voltaic copper had completely combined itself with the sheet on which it was deposited.

I then gave a plate a coating of cement, to a considerable thickness, and sent it to an engraver; but when it was returned, I found the lines were cleared out so as to be wedge-shaped, or somewhat in the form of a ∇, leaving a hair line of the copper exposed at the bottom, and a broad space near the surface; and where the turn of the letters took place, the top edges of the lines were galled and rendered rugged by the action of the graver. This, of course, was an important objection; which I have since been able to remedy, in some respects, by an alteration in the shape of the graver, which should be made of a shape more resembling a narrow parallelogram than those in common use—some engravers have many of their tools so made. I did not put this plate in action, as I saw that the lines, when in relief, would have been broad at the top and narrow at the bottom. I took another plate, gave it a coating of the wax, and had it written on with a mere point. I deposited copper on the lines, and afterwards had it printed from.

I now considered part of the difficulties removed: the principal one that yet remained was, to find a cement or etching-ground, the texture of which should be capable of being cut to the required depth, without raising (what is technically termed) *a burr*, and, at the same time, of sufficient toughness to adhere to the plate, when reduced to a small isolated point, which would necessarily occur in the operation which wood-engravers term cross-hatching.

I tried a number of experiments with different combinations of wax, resins, varnishes, and earths, also with metallic oxides, all with more or less success.

The one combination that exceeded all the others in its texture, having nearly every requisite (indeed I was enabled to polish the surface nearly as smooth as a plate of glass), was principally composed of virgin wax, resin, and carbonate of lead; the white lead of the shops.

With this compound I had two plates, 5 inches by 7, coated over, and portions of maps cut on the cement, which I had intended should have been printed off and laid before the British Association at its meeting. I applied the same process to these as to others, dipping them in dilute nitric acid before putting them in action; indeed I suffered them to remain about ten minutes in the solution. I then put them into the voltaic arrangement. The action proceeded, slowly and perfectly, for a few days, when I removed them. I then applied heat, as usual, to remove the cement, when all came away, as in a former instance; the voltaic copper peeling off the plate with the greatest facility. I was much puzzled at this unexpected result, but, on cleaning the plate, I discovered a delicate

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tracing of lead, exactly corresponding to the lines drawn on the cement previous to the immersion in the dilute acid. The cause of this failure was at once obvious; the carbonate of lead I had used to compound the etching ground had been decomposed by the dilute nitric acid, and the metallic lead thus set free had deposited itself on the exposed portions of the copper-plates, preventing the voltaic copper from chemically combining with the sheet copper. I was now obliged with regret to give up this compound—although, under other circumstances, I have no doubt it may be rendered available. I adopted another, consisting of bees'-wax, common whiting, resin, a small portion of gum, and plaster of paris. This seems to answer the purpose tolerably, though I have no doubt, by an extended practice, a better may still be obtained.

I now proceed to the second, and I believe the most satisfactory portion of the subject. Although I have placed these experiments last, they were made simultaneously with the others already described; but, to render the subject more intelligible, I have placed them thus.

I have already stated that I was desirous of executing metallic ornaments by this means, in either cameo or intaglio; but, being well aware of the apparent natural law which prevents metallic deposition by voltaic electricity, without the presence of a metallic body, I perceived, in consequence, its uses, if any, would be extremely limited, as, whatever ornament it might produce, it would only be by adhering to the condition of a metallic mould.

I accordingly determined to make my first experiment on a very prominent copper medal. I placed it in a voltaic circuit, as already described, and deposited a surface of copper on one of its sides to about the thickness of a shilling. I then proceeded to get the deposition off. In this I experienced some difficulty, but ultimately succeeded. On examination with a magnifying glass, I found every line was as perfect as the coin was from which it was taken. I was then induced to use the same piece again, and let it remain a much longer time in action, that I might have a thicker and more substantial mould. I accordingly put it again in action, and let it remain until it had acquired a much thicker coating of the metallic deposition; but when I attempted to remove it from the medal, I found I was unable. It had, apparently, completely adhered to it.

I had often practised, with some degree of success, a method of preventing the oxidation of polished steel, by slightly heating it until it would melt virgin wax; it was then wiped, apparently, completely off, but the pores of the metal became impregnated with the wax.

I thought of this method, and applied it to a copper coin.

I first heated the piece, applied wax, and then wiped it so completely off, that the sharpness of the coin was not at all interfered with. I proceeded as before, and deposited a thick coating of copper on its surface, after the lapse of a few days. When I wished to take it off, I applied the heat of a spirit-lamp at the back; when a sharp crackling noise took place, and I had the satisfaction of perceiving that the coin was completely loosened. In short, I had a most complete and perfect copper mould of a halfpenny.

I have since taken some impressions from the mould thus taken; and, by adopting the above method with the wax, I got them out with the greatest ease.

I was now of opinion that this latter method might be applied to engraving much better than the method described in the first portion of this paper. Being aware that copper in a voltaic circuit deposited itself on lead with as much rapidity as on copper, I took a silver coin, and put it between two pieces of clean sheet lead, and placed them under a common screw press. From the softness of the lead, I had a complete and sharp mould of both sides of the coin. I then took a piece of copper wire, soldered the lead to one end, and a piece of zinc to the other, and put them into same voltaic arrangement I have already described. I did not, in this instance, wax the mould, as I felt assured that the deposited copper would easily separate from the lead, by the application of heat, from the different expansibility of the two metals.

In this result I was not disappointed. When the heat of a spirit-lamp was applied for a few seconds to the lead, the copper impression fell easily off. So complete do I think this latter portion of the subject, that I have no hesitation in asserting that fac-similes of any coin or metal, no matter of what size, may be readily taken, and as sharp as the original. To further test the capabilities of this method, I took a piece of lead plate, and stamped some letters on its surface to a depth sufficient to print from when in relief. I deposited copper on it, and found it came off easily.

I now come to the conclusion of my experiments on this subject. As I stated at first, my object was to deposit a metallic surface on a model of clay, or other non-metallic body, as, otherwise, I imagined the application of this principle would be extremely limited. I made many experiments to achieve this result, which I shall not detail, but content myself with describing that which ultimately was the most successful.

I took two models of an ornament, one made of clay, and the other of plaster of paris, soaked them for some time in linseed oil, took them out, and suffered them to dry, first getting the clean oil off the surface. When dry I gave them a thin coat of mastic varnish, when the varnish was as nearly dry as possible, but not thoroughly so, I sprinkled some bronze powder on that portion I wished to make a mould of. This powder is principally composed of mercury and sulphur. I had, however, a complete metallic coating on the surface of my model, by which I was enabled to deposit a surface of copper on it, by the voltaic method I have already described. I have also gilt the surface of a clay model with gold leaf, and have been successful in depositing the copper on its surface. There is likewise another, and (as I trust it will prove), a simpler method of attaining this object, but as I have not yet sufficiently tested it by experiment, I shall take another opportunity of detailing the method.

[At the close of the paper several specimens of coins and medals, some of them in the act of formation by the voltaic process, were exhibited to the members.]

ADDENDA.

TO ENGRAVE IN RELIEF ON A PLATE OF COPPER.

Take a plate of copper, such as are in use among engravers. It is not essential that it should be highly polished.

Have a piece of copper wire neatly soldered to the back part of it, and then give it a coating of either of the cements already mentioned. This is best done by heating the plate as well as the wax; or, to level the wax after it has had a coat, hold the back part of the plate over a charcoal fire, or spirit-lamp, taking care to hold it level.

Then write, or draw the design, on the wax, with a black-lead pencil or a point. The wax must now be cut through with a graver, or a steel point, taking special care that the copper is *exposed on every line.*

It must now be immersed in dilute nitric acid—say, three parts water to one acid. It will be at once seen whether it is strong enough, by the green colour of the solution, and the bubbles of nitrous gas eliminated. Let it remain long enough to allow the exposed lines on the plate to be *slightly* corroded; that the wax (which gets into the pores of the copper during the heating process), may be thoroughly got rid of. Practice will determine this, better than any rules.

The plate is now ready to be placed in the voltaic apparatus. After the voltaic copper has been deposited in the lines engraved in the wax, the surface of the formation will be found to be rough, more or less, according to the quickness of the action. To remedy this, rub the surface with a piece of smooth flag or pumicestone, with water. Then heat the plate, and wash off the wax groundwork with spirits of turpentine and a brush. The plate is now readyto be printed from at an ordinary press.

TO DEPOSIT A SOLID VOLTAIC PLATE, HAVING THE LINES IN RELIEF.

Take a plate of copper, lead, silver, or type-metal, of the required size, and engrave in it, to the depth requisite to print from, when in relief.

Contrary to ordinary engraving, the lines must be *flat* at the bottom, and as nearly as possible of the same depth. When so engraved (should the plate be copper or silver), heat it, and then apply a little bees' wax (what is termed virgin wax is preferable) mixed with a very small proportion of spirits of turpentine; and give the plate a coating of it. It may be laid on in a lump; and the heat of the plate should be sufficient to melt it. When on the eve of cooling, the plate should be wiped clean, and all the wax taken off, as sufficient will have entered the pores of the plate, to prevent the voltaic copper from adhering.

Then solder a piece of copper wire.

The plate must now receive a couple of coats of thick varnish on the back and edges (a preparation of shellac and alcohol does very well). I prefer, if the plate is large, to imbed it with plaster of paris or roman cement, in a box the size of the plate, allowing the wooden edge of the box to project just as much above the surface of the plate as you wish the thickness of the voltaic one to be. Care must be taken to keep the engraved surface of the plate clean.

It is now ready to be placed in the apparatus to be deposited on.

Should the plate be lead, or what is still better, type-metal, the preparation of wax does not require to be given to the plate, as, when it is deposited on to the given thickness, applying heat is sufficient to loosen the plates.

TO PROCURE FAC-SIMILES OF MEDALS, &c.

This may be done by two different methods; the one by depositing a *mould* of the voltaic metal on the face of the medal (having first heated it, and applied wax), and then depositing the metal (by a subsequent operation), in the mould so formed.

But the more ready way is, to take two pieces of milled *sheet* lead (cast lead not being equally soft), having surfaces perfectly clean and free from indentation. Put the medal between the two pieces of lead, subjecting the whole to pressure in a screw-press. A complete mould of both sides is thus formed in the lead, showing the most delicate lines perfect (in reverse). Twenty, or even a hundred, of these may be so formed on one sheet of lead, and are deposited by the voltaic process with equal or greater facility; as the more extensive the apparatus, the more regularly and expeditiously does the operation proceed. Those portions of the surface of the lead, where the moulds do not occur, may be varnished, to neutralize the voltaic action; or, a whole sheet of copper being deposited, the voltaic medals may afterwards be cut out.

A piece of wire must now be soldered neatly to the back of the leaden plate; it is then ready to be put in action.

[This applies to the formation of one side of a medal only. It requires extremely careful manipulation to form both sides; and as I think there may be a better method than the one I have hitherto

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adopted, I defer stating it until I have obtained the result of an experiment now in operation.]

A VOLTAIC IMPRESSION FROM A PLASTER OR CLAY MODEL.

This process is partially described in a preceding page, in addition to which I may state, that when the plaster or clay ornament is gilt with gold leaf, or bronzed, a copper wire should be attached to it, by running through from the back, until the point appears above the front service, or level with it will be sufficient. The other end must then be attached to the binding screw connecting it with the zinc, in all respects similar to any of the foregoing methods.

TO OBTAIN ANY NUMBER OF COPIES FROM AN ALREADY ENGRAVED COPPER-PLATE.

A copper-plate may be taken, engraved in the common manner, the lines being in *intaglio*. Procure an equal-sized piece of sheet-lead; lay it on the engraved side of the plate, and put both under a *very powerful* press; when taken out, the lead will have every line, in relief, that had been sunk in the copper.

A wood engraving may be operated on in like manner; as lead, being pressed into it, will not injure it.

A wire may now be soldered to the lead, then bed it in a box, and put it into the voltaic apparatus, when a copper-plate, being an exact fac simile of the original, will be formed.

In this process, care must be taken that the lead is clean and bright, as it comes from the roller in the milling process, and consequently free from any oxidation, which it soon acquires, if exposed to the atmosphere. It should be put in action as soon as possible after being taken out of the press.

REMARKS ON THE MANAGEMENT OF THE APPARATUS.

Next to electro-magnetism, there is no branch of science that requires more dextrous manipulation than voltaic, or electro-chemistry; the most trifling film of oxidation often retarding the action of the most powerful apparatus. But, in the present instance, slow action, and simplicity of arrangement being the predominating features, such nice attention to minutiæ is not absolutely necessary, or at least not so much so as to deter those hitherto unacquainted with the subject from practising.

In all cases, to ensure metallic connection, binding-screws are preferable to cups of mercury; but, in using them, the copper wire, where the attachment is made, must be brightened with a piece of emery paper, also the point of the screw where it presses on the wire. In soldering the wires to the plates, let as little resin be used as possible; sal ammoniac, or dilute muriatic acid, answers the purpose much better.

In these experiments I have invariably found an equal sized piece of zinc to answer best. In the construction of galvanic batteries in general, I am aware, this is a moot point with high authority; but my own practice, which has been by no means small, with batteries of every construction, has led me to the opinion that, wherever slow and equable action is required, the positive and negative electrodes should be of equal superficial area. Although amalgamated zinc plates are preferable where combined intensity and continuity of action are required, they must not be used, under any circumstances, for the present purposes. It will, likewise, be found to be essential that the thickness of the zinc be equal to that of the required deposition.

Let the porous bottom of the interior vessel, containing the zinc, be a little larger than either of the electrodes. I have hitherto used, for this purpose, either bottomless glass cylinders or wooden boxes, varnished, with plaster bottoms; but I should recommend a well glazed earthenware vessel, having no bottom, but a slight rim projecting inwards, to secure the plaster. The zinc should be occasionally taken out of the arrangement, during continuance of the process, and cleansed by washing it in water; the saline solution may also be renewed.

Crystals of sulphate of copper should be added, from time to time, to the cupreous solution; but, should the deposition require to be thick and long-continued, it will be necessary to take out the cupreous solution once or twice during the operation, and add an entirely fresh one, as the sulphuric acid, necessarily set free after the de-oxidisement of the copper, when it predominates to any extent, prevents the required action from taking place on the copper; instead of which, a sub or di-oxide of copper is deposited, in the form of a reddish brown powder, the solution being rendered colourless. When this takes place, the plate should be taken out, and well washed in very dilute nitric acid. I have tried several methods to take up the sulphuric acid as it was set free; pure clay answers this purpose pretty well, the acid combining to a certain extent with it, and forming a sulphate of alumina, or alum, at the bottom of the vessel.

When the voltaic copper is bent, it breaks at a similar angle to cast copper; but when heated to a red heat, and slowly cooled, it assumes somewhat of the pliability of rolled sheet copper, requiring to be bent several times before breaking; should it now be beaten on an anvil, it will resume its brittleness.

It may be filed, polished, and cut with shears, in the usual manner, the surface acquiring as fine a polish as the copper in use among engravers.

Should a thick mass of metal be requisite for any practical purpose: as it would require a considerable lapse of time before it could be obtained by the voltaic process, the back of the deposited metal may be thickened, or filled up with solder, in a manner already practised in the arts, without the slightest injury to the surface or texture of the deposited metal.

INCREASED EFFICIENCY OF LIGHTNING CONDUCTORS.

M. PERROT has submitted to the French Academy of Sciences some remarkable observations. The metallic roof of a building, he says, whether communicating with the lightning conductor or not, does not preserve the metallic plates below it from the electric influence of the storm cloud. Each of these plates, if it be in connection with the conductor which receives the shock, sends off sparks to the neighbouring conducting bodies. If, then, we wish to avoid accidents similar to one which recently happened to a military store-house furnished with seven conductors, it is indispensable that each conductor should be placed where it will be perfectly sheltered from any electric shock, a position which M. Perrot says that he has obtained by a very simple arrangement, exemplified by the following experiments:—At an explosive distance from a disc, representing a cloud, and in connection with the electric machine, he places a metallic wire connected with the earth, and representing the lightning conductor to be attacked. Parallel to this disc, and at a little distance from each other, are disposed several metallic leaves or gratings, separated several centimetres from each other. These, designed to represent the roof and the metallic plates beneath it, may be connected with each other, or the conductor. Now, when these leaves are insulated from the struck conductor, the spark and the commotion felt by the hand touching these leaves, are not felt very sensibly; but if one of these leaves be put in connection with the conductor, it will (to the exclusion of all others), give rise to a powerful spark and commotion. The same will occur with each leaf, and with the whole, if connected with the conductor each time it is struck. M. Dumas, who was present, said that M. Perrot had put his hand on a problem of the very highest importance, and would no doubt give a complete solution of it, to the great satisfaction of philosophers, architects, and naval officers.—*Illustrated London News.*

THE GALVANIC CIRCUIT INVESTIGATED MATHEMATICALLY.

BY DR. G. S. OHM.*

IN compliance with the desire of a considerable section of our readers, we commence this week the reproduction of the valuable paper of Professor Ohm of Neuremburg, in which was first given a detailed exposition of the mathematical theory of the voltaic circuit now generally received. The paper will be continued from week to week until its completion. The portion given in each number must, however, be limited; the subject being somewhat abstruse to the majority of the readers of a *popular* scientific journal.

PREFACE.

I herewith present to the public a theory of galvanic electricity, as a special part of electrical science in general, and shall successively, as time, inclination, and means permit, arrange more such portions together into a whole, if this first essay shall in some degree repay the sacrifices it has cost me. The circumstances in which I have hitherto been placed, have not been adapted either to encourage me in the pursuit of novelties, or to enable me to become acquainted with works relating to the same department of literature throughout its whole extent. I have, therefore, chosen for my first attempt a portion in which I have the least to apprehend competition. May the well-disposed reader receive the performance with the same love for the object as that with which it is sent forth. THE AUTHOR.

INTRODUCTION.

The design of this memoir is to deduce strictly from a few principles, obtained chiefly by experiment, the rationale of those electrical phenomena which are produced by the mutual contact of two or more bodies, and which have been termed galvanic: its aim is attained if by means of it the variety of facts be presented as unity to the mind. To begin with the most simple investigations, I have confined myself at the outset to those cases where the excited electricity propagates itself only in one dimension. They form, as it were, the scaffold to a greater structure, and contain precisely that portion, the more accurate knowledge of which may be gained from the elements of natural philosophy, and which, also, on account of its greater accessibility, may be given in a more strict form. To answer this especial purpose, and at the same time as an introduction to the subject itself, I give, as a forerunner of the compressed mathematical investigation, a more free, but

* "*Die Galvanische Kette mathematisch bearbeitet von Dr. G. S. Ohm: Berlin*, 1827." Translated from the German by Mr. William Francis, Student in Philosophy in the University of Berlin.

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not, on that account, less connected, general view of the process and its results.

Three laws, of which the first expresses the mode of distribution of the electricity within one and the same body; the second the mode of dispersion of the electricity in the surrounding atmosphere; and the third the mode of appearance of the electricity at the place of contact of two heterogenous bodies, form the basis of the entire memoir, and at the same time contain everything that does not lay claim to being completely established. The two latter are purely experimental laws; but the first, from its nature, is, at least partly, theoretical.

With regard to this first law, I have started from the supposition that the communication of the electricity from one particle takes place directly on to the one next to it, so that no immediate transition from that particle to any other situate at a greater distance occurs. The magnitude of the transition between two adjacent particles, under otherwise exactly similar circumstances, I have assumed as being proportional to the difference of the electric forces existing in the two particles; just as, in the theory of heat, the transition of caloric between two particles is regarded as proportional to the difference of their temperatures. It will thus be seen that I have deviated from the hitherto usual mode of considering molecular actions introduced by Laplace; and I trust that the path I have struck into will recommend itself by its generality, simplicity, and clearness, as well as by the light which it throws upon the character of former methods.

With respect to the dispersion of electricity in the atmosphere, I have retained the law deduced from experiments by Coulomb, according to which, the loss of electricity, in a body surrounded by air, in a given time, is in proportion to the force of the electricity, and to a coefficient dependent on the nature of the atmosphere. A simple comparison of the circumstances under which Coulomb performed his experiments, with those at present known respecting the propagation of electricity, showed, however, that in galvanic phenomena the influence of the atmosphere may almost always be disregarded. In Coulomb's experiments, for instance, the electricity driven to the surface of the body was engaged in its entire expanse in the process of dispersion in the atmosphere; while in the galvanic circuit the electricity almost constantly passes through the interior of the bodies, and consequently only the smallest portion can enter into mutual action with the air; so that, in this case, the dispersion can comparatively be but very inconsiderable. This consequence, deduced from the nature of the circumstances, is confirmed by experiment; in it lies the reason why the second law seldom comes into consideration.

The mode in which electricity makes its appearance at the place of contact of two different bodies, or the electrical tension of these bodies, I have thus expressed: when dissimilar bodies touch one another, they constantly maintain at the point of contact the same difference between their electroscopic forces.

With the help of these three fundamental positions, the conditions to which the propagation of electricity in bodies of any kind and form is subjected may be stated. The form and treatment of the different equations thus obtained are so similar to those given for the propagation of heat by Fourier and Poission, that even if there existed no other reasons, we might with perfect justice draw the conclusion that there exists an intimate connection between both natural phenomena; and this relation of identity increases the further we pursue it. These researches belong to the not difficult in mathematics, and on that account can only gradually obtain general admission; it is, therefore, a fortunate chance, that in a not unimportant part of the propagation of electricity, in consequence of its peculiar nature, those difficulties almost entirely disappear. To place this portion before the public is the object of the present memoir, and, therefore, so many only of the complex cases have been admitted, as seemed requisite to render the transition apparent.

The nature and form commonly given to galvanic apparatus favours the propagation of the electricity only in one dimension; and the velocity of its diffusion, combined with the constantly acting source of galvanic electricity, is the cause of the galvanic phenomena assuming, for the most part, a character which does not vary with time. These two conditions, to which most frequently galvanic phenomena are subjected, viz., change of the electric state in a single dimension, and its independency of time, are however precisely the reasons why the investigation is brought to a degree of simplicity which is not surpassed in any branch of natural philosophy, and is altogether adapted to secure incontrovertibly to mathematics the possession of a new field of physics, from which it had hitherto remained almost totally excluded.

The chemical changes which so frequently occur in some, generally fluid, portions of a galvanic circuit, greatly deprive the result of its natural simplicity, and conceal, to a considerable extent, by the complications they produce, the peculiar progression of the phenomenon; they are the cause of an unexampled change of the phenomenon, which gives rise to so many apparent exceptions to the rule, frequently even to contradictions, in so far as the sense of this word is itself not in contradiction to nature. I have distinctly separated the consideration of such galvanic circuits in which no portion undergoes a chemical change, from those whose activity is disturbed by chemical action, and have devoted a separate part to the latter in the Appendix. This total separation of two parts forming a whole, and, as might appear, the less dignified position of the latter, will find in the following circumstance a sufficient explanation. A theory, which lays claim to the name of an enduring and fruitful one, must have all its consequences in accordance with observation and experiment. This, it seems to me, is sufficiently established with respect to the first of the parts above-mentioned, partly by the previous experiments of others, and partly by some performed by myself, which first made me acquainted with the theory here developed, and subsequently rendered me entirely devoted to it. Such is not the case with regard to the second part. A more accurate experimental verification is in this case almost entirely wanting, to undertake which I need both the requisite time and means; and therefore I have merely placed it in a corner, from which, if worth the trouble, it may be drawn hereafter, and may then also be further matured under better nursing.

By means of the first and third fundamental positions we obtain a distinct insight into the primary galvanic phenomenon in the following way. Imagine, for instance, a ring everywhere of equal thickness and homogeneous, having, at any one place, in its whole thickness, one and the same electrical tension, *i. e.* inequality in the electrical state of two surfaces situated close to each other, from which causes, when they have come into action, and the equilibrium is consequently distributed, the electricity will, in its endeavour to re-establish itself, if its mobility be solely confined to the extent of the ring, flow off on both sides. If this tension were merely momentary, the equilibrium would very soon be re-established; but if the tension is permanent, the equilibrium can never be restored; but the electricity, by virtue of its expansive force, which is not sensibly restrained, produces in a space of time, the duration of which almost always escapes our senses, a state which comes nearest to that of equilibrium, and consists in this; that by the constant transmission of the electricity, a perceptible change in the electric condition of the parts of the body through which the current passes is nowhere produced. The peculiarity of this state, also occurring frequently in the transmission of light and heat, has its foundation in this; that each particle of the body situated in the circle of action receives in each moment just so much of the transmitted electricity from the one side as it gives off to the other, and therefore constantly retains the same quantity. Now since by reason of the first fundamental position, the electrical transition only takes place directly from the one particle to the other, and is, under otherwise similar circumstances, determined according to its energy by the electrical difference of the two particles, this state must evidently indicate itself on the ring, uniformly excited in its entire thickness, and similarly constituted in all its parts, by a constant change of the electric condition, originating from the point of excitation, proceeding uniformly through the whole ring, and finally again returning to the place of excitation; whilst at this place itself, a sudden spring in the electric condition, constituting the tension, is, as was previously stated, constantly perceptible. In this simple separation or division of the electricity lies the key to the most varied phenomena.

(To be continued.)

M. ROBIN'S SOIREES.

Amongst the various exhibitions at present open in the Metropolis in which scientific agencies are employed for the purposes of instruction or amusement, there are few which have given us more pleasure in visiting than the scientific *soirées* of M. Robin, the well known and deservedly famous "French wizard." The first part of the entertainment consists of a variety of astonishing feats and transformations, in which M. Robin shows himself not only to be a consummate master of the art of legerdemain, but also thoroughly well acquainted with the powerful resources which modern scientific discovery has placed at the disposal of those whose *forte* seems to be to astonish while they instruct. Electricity appears to be the conjuror's familiar spirit, and many wonderful tricks are effected by means of a monster induction coil. If the entertainment consisted of nothing beyond this, a notice of it would scarcely have been appropriate in our pages; but, unlike the generality of professors of the black art, M. Robin, in the second part of his entertainment, throws magic on one side and condescends to be

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governed by the ordinary laws which matter and force are supposed to obey. Briefly telling his audience that the induction coil has assisted in many of his previous ingenious deceptions, he brings the instrumennt on to the platform, and exhibits some of the extraordinary powers of this instrument. It is one of the largest—if not the largest—we have ever seen, containing no less than forty-eight miles of wire, and giving a spark twenty inches in length. Some of the experiments were very beautiful, and lost none of their attractiveness by being presented in a more artistic and elegant manner than is customary in a scientific lecture-room. Amongst these we may especially mention the imitations of the aurora borealis and the lightning cloud. We were, however, most pleased at witnessing the piercing of several thick pieces of glass by the spark; the greatest thickness of glass which this coil could pierce through is three and a half inches, but the experiment is attended with considerable danger. The entertainment concludes with some dissolving views, illustrating the different scenes which may be supposed to have been successively presented on the earth's surface during the geological epochs, correct representations of fossils dating from the period being shown beneath, whilst the animals themselves are seen above to be wandering about in all their preadamite ugliness. Several novel effects, illustrating moving water and volcanic eruptions are introduced which considerably heighten the illusion. Altogether, the entertainment is one which cannot fail to be interesting to all classes of visitors. The scientific man will see in M. Robin's experiments, striking and instructive illustrations of mechanical and electrical appliances, whilst the general audience will be cheated into receiving a considerable amount of information under the impression that they are being merely astonished and amused.—*Chemical News.*

THE CORRELATION OF PHYSICAL FORCES.*

BY W. R. GROVE, Q.C., M.A.

When, twenty years ago, Mr. Grove published his tentative "Lecture on the Correlation of Physical Forces," his doctrine, that the various matters which constitute the main objects of experimental physics, viz., heat, light, electricity, magnetism, chemical affinity and motion, are all correlative, or have a reciprocal dependence, met with considerable opposition. But when Mr. Grove's lecture took the more voluminous form of an essay, successive editions of which were called for, it became evident that the author's views, if not indorsed by philosophers generally, were at least favourably received by the majority of scientific men. Nor is this surprising; for, apart from the logical astuteness with which Mr. Grove handles his subject, his physical arguments are especially remarkable for their sound and almost flawless character.

"Physics," said Lord Bacon, "is that which inquires of the efficient cause and matter; metaphysics, that which inquires of the form and end;" and although Mr. Grove's essay is highly suggestive, yet he has wisely, almost wholly, avoided those realms of metaphysics, the exploration of which, though highly tempting, but too generally results in being entangled in a labyrinth of conjecture. But there is, indeed, no necessity for Mr. Grove to diverge from his legitimate subject, nor to graft metaphysical disquisitions upon physical facts. For although he wrote truly in 1843, when he regretted the poverty of physical experiments calculated to illustrate his subject, during late years numerous philosophers have been working so diligently in experimental science, that Mr. Grove is no longer at a loss for physical facts to support his arguments. He has freely made use of these in the present edition of his essay, which thus coming before us in the light of a new book, is entitled to be critically examined.

The expression, Correlation of Physical Forces, now admitted into all works treating of Physics, may be said to have been invented by Mr. Grove; and as the meaning he attaches to it is highly important, with reference to a consideration of his essay, we give his own words:—

The term Correlation, which I selected as the title of my Lectures in 1843, strictly interpreted, means a necessary mutual or reciprocal dependence of two ideas, inseparable even in mental conception: thus, the ideas of height cannot exist without involving the idea of its correlate depth; the idea of parent cannot exist without involving the idea of offspring. It has been scarcely, if at all, used by writers on physics; but there are a vast variety of physical relations to which, if it does not in its strictest original sense apply, cannot certainly be so well expressed by any other term. There are, for example, may facts, one of which cannot take place without involving the other; one arm of a lever cannot be depressed without the other being elevated—the finger cannot press the table without the table pressing the finger. A body cannot be heated without another being cooled, or some other force being exhausted in an equivalent ratio to the production of heat; a body cannot be positively electrified without some other body being negatively electrified, &c.

* Fourth Edition. Longmans.

Mr. Grove further observes, that by this meaning of correlation, it will be evident that any force capable of producing another may, in its turn, be produced by it; nay more, can be itself resisted by the force it produces in proportion to the energy of such production. With this distinct understanding of the sense attached by Mr. Grove to the term correlation, we are enabled to follow him in his examination of the relative action of physical forces, which he divides into motion, heat, electricity, light, and chemical affinity. Motion, he well observes, is the most obvious, and the most distinctly conceived, of all the affections of matter. That all nature is in motion is evident, not merely in masses, as with the planetary spheres, but also molecularly, or throughout its most intimate structure; and arguing on these premises, Mr. Grove maintains that motion, regarding it as force, cannot be annihilated, but is merely subdivided or altered in direction or character. Wave your hand, for example, the motion which has apparently ceased, is taken up by the air, from the air by the walls of the room, &c., and so by direct and reacting waves continually comminuted, but never destroyed. It is true that at a certain point we lose all means of detecting the motion, in consequence of our finite senses, but it nevertheless exists. There is, it must be confessed, something almost awful in the thought of the eternal motion of these aërial pulses, which, unperceived by human sense, are as obedient to the laws of force as the avalanche that thunders down the snow-crested mountain, or the ball impelled from the cannon's mouth. Mr. Babbage, in his ingenious ninth "Bridgewater Treatise," devotes a curious chapter to what he calls the "Permanent Impression of our Words," which so entirely supports Mr. Grove's theory respecting the indestructibility of motion, that we quote the passage bearing on it—"No motion impressed by natural cases, or by human agency, is ever obliterated. The ripple on the ocean's surface caused by a gentle breeze, or the still water which marks the more immediate track of a ponderous vessel gliding with scarcely expanded sails over its bosom, are equally indelible. The momentary waves raised by the passing breeze, apparently born but to die on the spot which saw their birth, leave behind them an endless progeny, which, reviving with diminished energy in other seas, visiting a thousand shores, reflected from each, and perhaps again partially concentrated, will pursue their ceaseless course till ocean be itself annihilated. So the pulsations of the air, once set in motion by the human voice, cease not to exist with the sounds to which they gave rise; and the air is thus one vast library, on whose pages are for ever written all that man has ever said or woman whispered."

In the same spirit of conservancy the poet says—

"Not a life shall be destroyed,
Or cast as rubbish in the void;"

and just as from the seed springs the plant producing seed, so is motion again reproduced by the forces that have emanated from motion.

The second chapter of Mr. Grove's essay is devoted to "Heat." That heat produces force is one of the most evident facts in physics. The power of the sun may be instanced, which is so great, that it is calculated that it would boil twelve thousand millions of cubic miles of ice-cold water in one minute. But heat, as Mr. Grove shows, is also the direct consequence of motion, while heat, in its turn, is capable of producing motion:—

If we put aside the sensations which heat produce in our own bodies, and regard heat simply as to its effects upon inorganic matter, we find that, with a very few exceptions, which I shall presently notice, the effects of what is called heat are simply an expansion of the matter acted upon, and that the matter so expanded has the power by its own contraction of communicating expansion to all bodies in contiguity with it. Thus, if the body be a solid, for instance, iron, a liquid, say water, or a gas, say atmospheric air—each of these, when heated, is expanded in every direction; in the two former cases, by increasing the heat to a certain point, we change the physical character of the substance, the solid becomes a liquid, and the liquid becomes a gas; these, however, are still expansions, particularly the latter, when, at a certain period, the expansion becomes rapidly and indefinitely greater. But what is, in fact, commonly done in order to heat a substance, or to increase the heat of a substance? it is merely approximated to some other heated, that is, to some other expanded substance, which latter is cooled or contracted as the former expands. Let us now divest the mind of the impression that heat is in itself anything substantive, and suppose that these phenomena are regarded for the first time, and without any preconceived notions on the subject; let us introduce no hypothesis, but merely express, as simply as we can, the facts of which we have become cognizant; to what do they amount? to this, that matter has pertaining to it a molecular repulsive power, a power of dilatation, which is communicable by contiguity or proximity.

Heat thus viewed is motion, and this molecular motion we may readily change into the motion of masses, or motion in its most ordinary and

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palpable form: for example, in the steam-engine, the piston and all its concomitant masses of matter are moved by the molecular dilatation of the vapour of water.

But Mr. Grove proceeds further, and having shown the correlative properties of motion and heat, he next shows how it produces light and electricity. Electricity again, in its turn, produces magnetic effects, both forces being accompanied by molecular changes, which we know are always going on under the influence of heat. That electricity has the power of initiating force is also very evident, as we get motion directly produced by it in various forms; for instance, in the attraction and repulsion of bodies, evidenced by mobile electrometers, such as that of Cuthbertson where large masses are acted on: the rotation of the fly-wheel, another form of electrical repulsion, and the deflection of the galvanometer needle, all of which are modes of palpable, visible motion. Mr. Grove devotes a large portion of his essay to the consideration of "Light," the reciprocal relations of which, as a mode of force, have been the least traced out. The effect of light on chemical compounds affords a striking instance of the extent to which a force, ever active, may be ignored through successive ages of philosophy. The general reader may not be prepared to associate light with motion or force, but that the former produces the latter Mr. Grove shows by the following beautiful experiment:—

A prepared Daguerreotype plate is enclosed in a box filled with water, having a glass front with a shutter over it. Between this glass and the plate is a gridiron of silver wire; the plate is connected with one extremity of a galvanometer coil, and the gridiron of wire with one extremity of a Breguet's helix—an elegant instrument, formed by a coil of two metals, the unequal expansion of which indicates slight changes in temperature; the other extremities of the galvanometer and helix are connected by a wire, and the needles brought to zero. As soon as a beam of either daylight, or the oxyhydrogen light is, by raising the shutter, permitted to impinge upon the plate, the needles are deflected. Thus, light being the initiating force, we get *chemical action* on the plate, *electricity* circulating through the wires, *magnetism* in the coil, *heat* in the helix, and *motion* in the needles.

Light is also known to produce heat in the phenomena of what is termed absortion of light, which show that heat is developed in proportion to the disappearance of light. To produce heat, however, absorption of light must take place, for if a medium be perfectly transparent, or if a surface perfectly reflects light, not the slightest heating effect takes place. These results, which at first sight may seem trivial, are nevertheless pregnant with importance when considered in their various relations to matter. See, for example, how, viewed by philosophy, they affect the question, "Are the planets inhabited?" which recently agitated the scientific world:—

These effects have an important bearing on certain cosmical questions which have lately been much discussed, and should induce the greatest caution in forming opinions on such subjects as light and heat on the sun's surface, the temperature of the planets, &c. This may depend as much upon their physical constitution as upon their distance from the sun. Indeed, the planet Mars gives us a highly probable argument for this; for, notwithstanding that it is half as far again from the sun as the earth is, the increase of the white tracts at its poles during its winter, and their diminution during its summer, show that the temperature of the surface of this planet oscillates about that of the freezing point of water, as do the analogous zones of our planet. It is true, in this we assume that the substance thus changing its state is water, but, considering the many close analogies of this planet with the earth, and the identity in appearance of these very effects with what takes place on the earth, it seems a highly probable assumption.

So it by no means necessarily follows, that because Venus is nearer to the sun than the earth, that planet is hotter than our globe. The force emitted by the sun may take a different character at the surface of each different planet, and require different organisms or senses for its appreciation. Myriads of organized beings may exist imperceptible to our vision, even if we were among them; and we might be also imperceptible to them!

Since the original publication of this essay, Mr. Faraday's remarkable discovery of the effect of magnetic force in occasioning the deflection of a ray of polarized light, enables Mr. Grove to include magnetism as a correlative force, for whether this effect of magnetism is rightly termed an effect upon light and heat, or is a molecular change of the matter transmitting the light and heat, it is certain that magnetism directly affects the other forces. But apart from this consideration, magnetism possesses a dynamic condition. This is illustrated by iron or steel, the molecules of which are in motion while the metal is passing from its non-magnetic to its maximum magnetic state, or recedes from its maximum magnetic state to zero.

The last division in the essay is "Chemical Affinity," or the force by which dissimilar bodies tend to unite and form compounds differing generally in character from their constituents. This mode of force, though probably that of which the human mind has hitherto formed the least definite idea, is nevertheless apparent in many cases. For example, there are few, if any, chemical actions which cannot be experimentally made to produce electricity. The enormous power of the voltaic battery, generated by the chemical action of acids on zinc, is well known: and so powerful is this latent force, that it is no Utopian belief that long before our coal-measures are exhausted, wonder-working chemistry will have invented not only a mechanical power superior to steam, but sources of heat which will render us independent of fuel.

Such are the principal heads of Mr. Grove's inquiries into the Correlation of Physical Forces, but in the true spirit of a philosopher, who ever seeks to unfold the secrets of nature, he devotes a chapter to the consideration of other probable modes of force, such as gravitation, inertia, and aggregation. Gravitation, however, in Mr. Grove's opinion, would only produce other force when the motion caused by it ceases. With this we entirely agree, but at the same time the laws of gravitation and inertia are so subtle that it would be rash to assert that their phenomenal effects are small.

Not the least interesting portion of this masterly essay is that containing the author's concluding remarks. Every line of these deserves to be studied, for each is the result of great thought. The following passage is especially worthy of attention:—

In investigating the relation of the different forces, I have in turn taken each one as the initial force or starting-point, and endeavoured to show how the force thus arbitrarily selected could mediately or immediately produce and be merged into the others: but it will be obvious to those who have attentively considered the subject, and brought their minds into a general accordance with the views I have submitted to them, that no force can, strictly speaking, be initial, as there must be some anterior force which produced it: we cannot create force or motion, any more than we can create matter.

Thus, to take an example previously noticed, and recede backwards; the spark of light is produced by electricity, electricity by motion, and motion is produced by something else, say a steam-engine—that is, by heat. This heat is produced by chemical affinity, *i, e.* the affinity of the carbon of the coal for the oxygen of the air; this carbon and this oxygen have been previously eliminated by actions difficult to trace, but of the pre-existence of which we cannot doubt, and in which actions we should find the conjoint and alternating effects of heat, light, chemical affinity, &c. Thus, tracing any force backwords to its antecedents, we are merged in an infinity of changing forms of force; at some point we lose it, not because it has been in fact created at any definite point, but because it resolves itself into so many contributing forces, that the evidence of it is lost to our senses or powers of detection; just as, in following it forward into the effect it produces, it becomes, as I have before stated, so subdivided and dissipated as to be equally lost to our means of detection.

Can we, indeed, suggest a proposition, definitely, conceivable by the mind, of force without antecedent force? I cannot, without calling for the interposition of creative power, any more than I can conceive the sudden appearance of a mass of matter come from nowhere, and formed from nothing. The impossibility, humanly speaking, of creating or annihilating matter, has long been admitted, though, perhaps, its distinct reception in philosophy may be set down to the overthrow of the doctrine of Phlogiston, and the reformation of chemistry at the time of Lavoisier. The reason for the admission of a similar doctrine as to force appear to be equally strong. With regard to matter, there are many cases in which we never practically prove its cessation of existence, yet we do not the less believe in it: who, for instance, can trace, so as to re-weigh, the particles of iron worn off the tire of the tire of a carriage wheel? who can re-combine the particles of wax dissipated and chemically changed in the burning of a candle? By placing matter undergoing physical or chemical changes under spacial limiting circumstances, we may, indeed, acquire evidence of its continued existence, weight for weight; and so we may in some instances of force, as in definite electrolysis; indeed the evidence we acquire of the continued existence of matter is by the continued exertion of the force it exercises, as, when we weigh it, our evidence is the force of attraction; so, again, our evidence of force is the matter it acts upon. Thus, matter and force are correlates, in the strictest sense of the word; the conception of the existence of the one involves the conception of the existence of the other: the quantity of matter again, and the degree of force, involve conceptions of space and time. But to follow out these abstract relations would lead me too far into the illuring paths of metaphysical speculation.

It will not, in all probability, be ever given to man to know the ultimate structure of matter, or the minutiæ of molecular actions; but many new phenomena remain to be discovered connected with causative agences. Let it ever be remembered, that even after Newton had made his great discoveries he compared himself to a little child who had discovered but one small pebble on the vast sea-shore: and thus, ust as increased powers of the telescope and microscope reveal more worlds and still more minute life, so will increased mental power

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and study make us acquainted with new phenomena illustrating the fact that neither matter nor force can be created or annihilated—and that an essential cause is unattainable, causation being the will, creation the act of God.—*The Parthenon.*

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5	London District Telegraph .	$4\frac{3}{4}$	4 to 3 dis.	——
10	Lond. & S. Ireld. Direct Tel.	2	—— pm.	——
10	Mediterranean Extension Tel.	all	3 to 4	——
10	Do. 8 per cent. pref.	all	——	——
1	Submarine Telegraph, scrip.	all	[illegible] to [illegible]	——
1	Do. registered . . .	all	[illegible] to [illegible]	——
10	Do. „ . . .	all	4 to 6	——
2	Telegraph to India . .	1	$\frac{5}{8}$ to $\frac{3}{8}$ dis.	——
5	United Kingdom Telegraph .	3	$\frac{1}{2}$ dis. to par.	——

ATMOSPHERIC ELECTRICITY.

MANY years since, I was sitting in my electrical room on a dark November day, during a very dense driving fog and rain, which had prevailed for many hours, sweeping over the earth, impelled by a south-west wind. The mercury in the barometer was low, and the thermometer indicated a low temperature. I had at this time 1,600 feet of wire insulated, which, crossing two small valleys, brought the electric fluid into my room. There were four insulators, and each of them was streaming with wet, from the effects of the driving fog. From about eight o'clock in the morning until four in the afternoon, not the least appearance of electricity was visible at the atmospheric conductor, even by the most careful application of the condenser and multiplier; indeed, so effectually did the exploring wire conduct away the electricity which was communicated to it, that when it was connected by means of a copper wire with the prime conductor of my 18-inch cylinder in high action, and a gold leaf electrometer placed in contact with the connecting wire, not the slightest effect was produced upon the gold leaves. Having given up the trial of further experiments upon it, I took a book, and occupied myself with reading, leaving by chance the receiving ball at upwards of an inch distance from the ball in the atmospheric conductor. About four o'clock in the afternoon, whilst I was still reading, I suddenly heard a very strong explosion between the two balls, and shortly after many more took place, until they became one uninterrupted stream of explosions, which died away and re-commenced with the opposite electricity in equal violence. The stream of fire was too vivid to look at for any length of time, and the effect was most splendid, and continued without intermission, save that occasioned by the interchange of electricities, *for upwards of five hours*, and then totally ceased. During the whole day, and a great part of the succeeding night, there was no material change in the barometer, thermometer, hygrometer, or wind; nor did the driving fog and rain alter in its violence. The wind was not high, but blew steadily from the S.W. Had it not been for my exploring wire, I should not have had the least idea of such an electrical accumulation in the atmosphere: the least contact with the conductor would have *occasioned instant death*, the stream of fluid far exceeding anything I ever witnessed, excepting during a thunder-storm. *Had the insulators been dry what would have been the effect?* In every acre of fog, there was enough of accumulated electricity to have destroyed every animal within that acre. How can this be accounted for? How much have we to learn before we can boast of understanding this intricate science?—*Andrew Crosse.*

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

SIR,—In glancing through the columns of the *Daily Telegraph* of to-day, I observed a letter headed "Telegraph Delays," in which the writer brings a very grave charge against the District Telegraph Company; after giving minute particulars of the case, he winds up by saying:—"This has taught me a lesson; and in matters of importance, never more will I trust to the 'wires' while they are handled by such active and trustworthy clerks as the above named company employ."

Surely such constant and reiterated complaints must awaken the responsible authorities in Telegraph Companies to some sense of the injury that they are doing to their own interests, as well as the great risks that the public, who are not yet alive to the defects of the details of management, must daily expose themselves to, both in purse and person. Everyone must consider it infamous that any public company should be allowed to monopolize a line of communication, not only by the erection of hideous posts upon the tops of the houses in London, strongly reminding one of magnified linen posts and clothes' lines, and bringing before the lively imagination of Paterfamilias as he wends his way from Westbourne to the Bank, all the horrors of his economical and eccentric spouse, who still holds to the antiquated delusion of a weekly wash.

Is it not enough that these despotic companies should be permitted to render hideous our most public and best constructed streets; by introducing an artificial horizon, or sky-line, as it were, and thereby dwarfing the apparent altitude of some of our finest commercial architectural elevation. As this machinery decays, I presume we may one day read, amongst the Coroner's Inquest Reports, that some friend has been crushed, like another "Laocoon," among the folds of an erratic telegraph wire, as as he was walking along with his innocent and unsuspecting sons. The picture was very nearly realized in the Camberwell Road, not far from the Elephant and Castle, not many months since, but, *unhappily*, not one of the Directors of the company, was in any way individually injured.

Jack Tar congratulates himself during a hurricane that he is not on shore, as he sings, "My eyes and limbs, what chimney pots around their heads are falling;" but now-a-days he may add a fresh verse to his song, especially as he will shortly cease to be able to speak of the wooden walls of Old England afloat. Iron plates and iron wires will soon make him sing to another tune, an entirely different song.

Is it not sufficient that these arbitrary Mercurys should be allowed to obstruct the public the public thoroughfare with their constant disturbance of the pavement, for the purpose of putting down or repairing their electric arteries as they ramify through the heart of London? Are not all these privileges and opportunities for annoying the body community sufficient for them that they are to be allowed to entangle people in their spider's web with impunity, and after having enticed their victims into their offices with delusive promises of expeditious and accurate communication, they are to be allowed to laugh in their faces, when any well-grounded cause of complaint is brought against them? I see no hope of bringing them to book until some notice of the matter is taken in Parliament, and some concise bill is brought in defining their duties and liabilities, so that the public may have a ready and inexpensive method of compelling telegraph officials to be prompt and accurate in their business.

If, as I have before urged, the employment of women were to become more general in Telegraph Offices, we might at least feel some degree of confidence that when we entered these offices, we should be met with a becoming civility and attention, and not have to encounter the covert badinage and ill-concealed insolence of beardless boys. This arrangement, together with proper legislative enactments clearly defining the terms of the implied contract between the public, who avail themselves of the convenience of telegraphic communication, and the companies which are allowed to monopolize the locality, would render such means of mutual correspondence one of the greatest social and mercantile advantages that have derived their existence from scientific discovery and applied chemistry.

Hoping that reiterated complaints, like the constant dropping of water upon stone, may make some impression upon the hard heads of those most chargeable with the present defects, and that we may shortly see a great change in these matters. I beg to offer my apologies for taking up so much room in your journal, and remain yours obediently,

PHILANTHROPOS.

London, 27th September, 1862

To the Editor of THE ELECTRICIAN.

SIR,—I beg to offer to your notice a new form of battery, which has suggested itself to me as possessing all the qualities of quantity and

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intensity, and likewise does away with the porous jar, though still retaining all the effects of a battery with a porous jar. With a battery of cast iron and zinc, as given in one of your late numbers, the quantity is undoubtedly very great, but the tension is very small. I propose to reverse the arrangement, by placing the cast iron negative and zinc in one jar, with the usual exciting fluid; so far the arrangement retains all its properties of a quantity current, but to give it intensity and *still more in quantity*, I propose to have the cast iron negative made in the form of the porous jar, with the exception that there will be no bottom to the iron cell, but this is to be replaced by a bottom of plaster of paris. Now here we have the iron negative acting as a porous cell, still retaining its original quantity arrangement. By filling the iron cell with nitric acid the whole arrangement will act, I anticipate, in a very powerful manner. I shall be glad of your opinion.—Yours truly, J. COOK.

TEXTS FROM THE BLUE BOOK—No. VI.

To the Editor of THE ELECTRICIAN.

SIR,—Dipping into the Blue Book, as is my wont, when seeking for that compound article, amusement and instruction, I, by chance, opened at page 89, and forthwith commenced reading the evidence of Mr. Thomas Barnabas Daft.

Now, I have pretty well fingered every page of this Book, and thought I was tolerably familiar with the names of the gentlemen whom the Government Committee delighted to honour, and also with the general character of the separate evidence of each. But I must candidly avow, I never met with this gentleman's name before; and, indeed, I was so astonished at coming across a name unfamiliar to me in that quarter, that I at once turned back to the title-page, to make sure that it was, in very truth, the Blue Book I was reading; and in order to be further convinced, and to place the matter beyond all doubt, I closed the book, and examined its cover. Yes, there is no mistake about it; the shade is indigo (or I should say, was, for it has assumed a smoky hue latterly); and here is its circumstantial and elaborate title; yes, and just below is the good-natured lion and the vixenish unicorn, and the tom-cat with a top-knot, perched on a something that is supposed to represent the regal diadem of Her Britannic Majesty; the whole concluded with the names of the printers, whose sole prerogative it is to print Blue Books, and "price £1." Well, insignificant as this may appear, it is quite enough to bring me down a notch or two, for I had assumed to know more about this volume than I had any title to; so rejoice, my friends, ye who feel disposed, at my discomfiture. We may moralize, here, about all sorts of things which come under our nose every day, and yet we don't know half so much about them as we do of the interior of Australia, the ruins of Babylon, or the habits of the Mastodon. From this time forth I will be more circumspect, I promise you; I shall not stand on tip-toes, much less mount on the shoulders of my friends.

I shall be deceived if I do not come across numberless other matters in this volume, of which, at present, I have no conception; fortunately, I am not vain, and so the confessing has not lacerated that part of my composition where that quality is supposed to be entrenched.

Saith the Chairman—but whether in a bantering way, or inquisitively, or because, from a previous knowledge, he was satisfied upon the point, it would be hard to tell—"I believe you have produced a very good insulating material?" With commendable modesty, T. B. D. answers, "I think so." And here the query forces itself upon us, Did the producer succeed in making his interlocutors "think so?" I fear we shall be compelled to negative the question, as no reference is made to this "good insulating material" in the Report; and yet there were other materials commended therein, which would appear to have hardly so much claim to notice as the one in question, while others were noticed only to be rejected. We shall, perhaps, therefore, be not far wrong, if we suppose that this was esteemed neither very good, nor yet very bad, like a certain hero whose history we were familiar with before we were breeched. I think, however, in justice to the inventor, some reference should have been made to his invention. If he were esteemed worthy to undergo an examination in regard to its merits, it was surely entitled to a passing remark in the Report, since due prominence should have been given to every effort, however humble, which had for its object the furtherance of submarine telegraphic efficiency. Apart from the question of self-interest, which is the main-spring, in a greater or less degree, of every effort and all enterprizes in which mankind engage, it is manifest that all who contributed either specimens or experience for facilitating the Government Committee in their attempt to solve the problem of ocean telegraphy, even where their contributions had nothing to recommend them but a good intent, deserved the gratitude of the public, and every consideration at the hands of the Committee.

Doubtless those persons who have not seen the Blue Book, would be glad to know something about Mr. Daft's invention, without further preamble. Well then, this gentleman would have considerable pleasure in insulating a cable for you, say for Gibraltar or anywhere else that will suit you, by means of vulcanized india rubber which is made to adhere to the wire by means of steam power, and a pressure of 40 lbs to the inch—the adhesion and vulcanization occurring, as it would seem, simultaneously—it further appears that this insulating material is laid on the wire longitudinally, then passed through a machine, where, by means of pressure, the different layers and sections become one solid mass (not forgetting the steam, however, with your pressure). You are not to suppose that because the rubber sticks to the metal more persistently than any friend will ever stick to you, that it is, perforce, a mechanical connection (although I must admit you have very good grounds for thinking so, taking into account the mechanical force brought to bear upon it); by no means; the connection is chemical; and doubtless if you were subject to a similar process, you would have a chemical affinity for things which under your present circumstances are repelling rather than otherwise. Hence, however odd it may seem, we must even be content to consider it a chemical union, and as I am not a practical and experimental chemist myself, I think I had better say no more about it; because, as you are aware, when people are ignorant they should be mum, and then they will be esteemed wise, which is far from disagreeable.

I may just observe, however, the grounds assigned for its being a chemical, and not a mechanical connection, are, that you may, with comparative ease, strip or dissever the latter; whereas the former will defy your every effort, although you cut it to the bone.

Mr. Daft will tell you that india rubber when brought into contact with the metal by any other process than his own, is doomed to certain and speedy destruction; but from what cause it doth not appear: we may assume however, that he means by oxidation. In passing, I may be allowed to say that this is purely gratuitous; experience proves that oxidation *does not* ensue in the ordinary application of india rubber to a copper conductor, if the right sort be used, and the state of both materials, and attendant circumstances, are properly looked after. As applied to ordinary adulterated rubber, Mr. Daft's assertion is doubtless approximatively true; but there is no experienced cable manufacturer who has any regard for his own credit, and a sincere wish for efficient india rubber insulation, would ever apply such a material next the wire, since it is utterly out of his power to guarrantee that there shall not be some ingredient in manufactured india rubber inimical to its durability when brought into such connection. Happily, there is no occasion for using it: and in justice to Mr. Daft it must be admitted that if his process of adhesive vulcanization as applied to all descriptions of rubber indiscriminately, will prevent the metal from acting distinctively upon the gum, he has achieved no mean thing, and is entitled to commendation, But if it apply to pure rubber only, then his premises are wrong, and his invention sinks into insignificance as compared with a simpler method of insulation, having other circumstances to recommend it, which by Mr. Daft's peculiar process it is impossible to secure, notwithstanding their indispensability.

There is a singular peculiarity about this insulating material; it will not adhere to all metals, pure copper being one of them; and as this undisseverable cohesiveness is the quality which, in its inventor's estimation, establishes its principal claim to adoption as a successful insulator, inasmuch as it secures it against decay, and also ensures compact homogeneity; it will be seen that its principal virtue is thus its greatest defect. If it will not perfectly adhere to copper, where is the good of it? since it is essentially necessary to employ the best conductor in submarine cables, and we have Mr. Daft's own testimony that it adheres most perfectly to brass; thus, in order to secure the services of pure copper at all, with such an insulator it would be necessary to put it on a coat of mail.

I would just recur again to the point relative to the effects of rubber and metal when brought into contact. Of course the rubber used by Mr. Daft being vulcanized, it is necessarily sulphurized also; now, anyone with a little experience in these matters must be aware that the sulphur contained in vulcanized india rubber is prejudicial to most metals, and the reaction of the metal upon the sulphurized gum is also by no means favourable thereto; indeed, such are the pernicious effects of the sulphur that if any one of my readers are ever likely to finger vulcanized rubber I would recommend him beforehand to leave his peg and chain at home, also his silver repeater thereto attached, and any other personal adornments common to the times of the same metallic nature. Now, are we to conclude that the peculiar chemical connection, which occurs at the period of perfect cohesion, nullifies the effects above alluded to, and so results in mutual support and durability, instead of mutual antagonism, if not destruction, as under other circumstances? It is a subject fraught with some little interest, being so contrary to ordinary experience.

Mr. Daft claims for his insulating material some rare virtues. You may, for instance, roll it up any way without fear of making a kink, indeed, that is simply an impossibility; the joints, too, can be made without any difficulty, and perfectly effective; for the matter of that, if you have any where to stow your cable, there is no necessity for your having a joint in at all, even if it be a thousand miles long. This is the cable, then, wherewith to belt the earth in one unbroken circuit, like a beer barrel. What could the Committee be thinking of to pass it over unnoticed, with not even one word of recommendation? But Mr. D., I fear, was too modest to forward his own interests; a man should never speak subjunctively before a Government Committee. I shall, perhaps, incur the charge of fiddling too much upon one string, but I must say again, if you have anything to advance, especially if it affect number one, give it a full mouth, never doubting; for if you doubt your audience will do the same; if the opposite, they will say, "this man has merit, inscribe his name in the book of our remembrance."

Take an instance, Mr. Daft speaks thus as to its durability, "(2145) I do

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not say that it would last fifty years, but I verily believe it would last ten years or 12 years, and in deep water that it would last much longer, probably even over fifty years." Again, "(2151) I think a cable like that would last a great many years, &c."

I must confess I like the candour, the unobtrusive honesty of Mr. Daft's evidence, as seen in his not over-estimating the merits of his insulating material. I may be younger in years than he, I may be older; nevertheless, as the results of my experience, I would say, exclude "probably" from your vocabulary, and never use such a phrase as "I think;" you know in what instances.

To the use of these dubious expressions Mr. Daft in part owes the exclusion of his material from mention in the Committee's Report.

Of course this cable can be "paid out easily;" but then that can scarcely be considered a distinctive feature in its favour, since, by Captain Selwyn's method, the paying out of any cable is reduced to an exceedingly simple and easy process. Our text is tolerably lengthy, and these remarks can only be considered as a running commentary upon the evidence; and by this time I had arrived at the bottom of page 89. Could I do anything more reasonable than turn over? naturally, for I expected to find the subject continued; but it seems it suffers an abrupt termination at the bottom of this said page, just as I thought we were getting into the pith of it. Now, I have a peculiar feeling under such circumstances, which, I believe, had its origin about the adolescent period, when I was uncommon dreamy, and took especial delight in shadowy romance; in this wise, having been, for the space of three whole days absorbed in the adventures of certain heroes of the 10th century, in which the villainous Enulph plays old boots with all the good and virtuous people, including the chivalrous Edgar and his angelic Bertha, you come to page 366, vol. iii, where it is ominously recorded that "heart appaling sounds rent the air * * * the body of Enulph was no longer visible." Just so, I always knew he would come to grief; but I did not expect it to occur in such an unsatisfactory way; of course he went off in true demon-like style, but was it through the window, or up the chimney, or where? No, he has not even left his boots behind, for I have turned over the next page, and found it blank, and the next, and the next. Need I say how the matter perplexed me for the next three months? and that I was all but appealing to the clergyman of our parish to see if he could throw any light upon it, Mackenzie himself being among the shades.

Well, having come to the end of the evidence, the preacher should bring his preachment to a close. But you will now understand the reason if I defer that for a sentence or two. Has anyone else anything to say about the material we have had under consideration, commendatory or otherwise? Yes; I have peered very carefully through the Blue Book, and here it is—one solitary instance. W. Thompson, Esq., LL.D., under examination (2609): "Have you seen this insulator of Mr. Daft's, and formed any opinion of it?" "I do not think india rubber is strong enough; as far as I can judge, gutta percha is a much tougher (!) and stronger (!!) substance than any india rubber that could be found (!!!)."

There, Mr. Daft, that's a knock-down blow; the Professor knows more about india rubber than you do, I'll engage, Now for a word, on my own account, anent this assertion of Dr. Thompson's. To use a cockneyism, it is cool, passingly so. It was said that M. Siemens's assertion, in his paper on Submarine Cables, of the tendency of india rubber to decompose when submerged in water, was one of the most extraordinary statements ever put forth; extraordinary, from its being gratuitously unfounded. But those persons who were conversant with the state of matters, were well aware of the motives which dictated it. This assertion, strange as it was, is eclipsed by Professor Thompson's, quoted above.

Amicus.

Miscellanea.

Colonial Progress.—The Victoria Telegraph Company (Australia) has 50 offices, and 1516 miles of wire.

Railway Telegraphs.—In the number of *Annales Télégraphiques* for May-June, 1860, will be found the description of a system of railway telegraphs contrived by M. Regnault, which may be of special interest to those who are studying this question. We are not certain, however, that the paper is of sufficient importance, in point of originality of conception, to warrant its being quoted at length in our columns.

The Voltaic Couple of M. Grenet.—The peculiarity in the form of battery contrived by M. Grenet is, that the positive (zinc) element is exposed to the joint action of a solution of bichromate of potash, sulphuric acid, and atmospheric air, whereby its rapid oxidation, and the removal of the oxide, are greatly facilitated. The air is forced into the cells by bellows, which may be worked by hand or otherwise. The very considerable reduction of the "internal resistance" of the battery by these means, is a phenomenon which is interesting in a theoretical as well as a practical point of view. The battery, we need scarcely observe, is adapted, principally, for purposes in which a current of great "quantity" is required, and is not intended for employment in telegraphy. Its use has been suggested for giving signals, by means of the electric light, in military operations, for which purpose it appears specially available, as it combines quantity and intensity in a comparatively small volume, and requires but a small amount of manual labour, which, in this case, can well be spared.

Contraction and Expansion of Metals by the Effect of Charge.—It was discovered by M. C. Doppler, Professor of Mathematics at Prague, that a positive electrical charge, even of feeble tension, causes an insulated bar of metal to contract, while, under the influence of a negative charge, the metal expands. The following description of the experiment was given in Poggendorff's *Annalen*. A thin copper tube, about three feet long, is properly placed in a delicate compound lever apparatus, something similar to our lever-pyrometers, and properly insulated by glass stems. If, now, a feeble electric tension be given to the tube, the index of the lever apparatus immediately begins to move, indicating a *contraction* of the tube. By increasing the tension, the motion of the index is so swift that the eye cannot trace it; so that, for high electric tensions, a simple lever-apparatus answers better than the delicate compound one. When sparks are either intentionally taken from the tube, or are discharged spontaneously, the index rapidly recoils, indicating the expansion of the tube. This property of electricity is said to have been discovered with a single pair of plates.

Atmospheric Electricity.—It has been ascertained by the observations of De Saussure, Schubler, Arago, and others, that the positive electricity of the atmosphere is subject to diurnal variations of intensity; there being two *maxima* and two *minima* during the twenty-four hours. The first *minimum* takes place a little before the rising of the sun; as it rises, the intensity, at first gradually, and then rapidly, increases, and arrives at its first *maximum* a few hours after. This excess diminishes, at first rapidly, and afterwards slowly, and arrives at its *minimum* some hours before sunset; it re-ascends when the sun approaches the horizon, and attains its second *maximum* a few hours after; then diminishes till sunrise, and proceeds in the order already indicated. The intensity of the free electricity of the atmosphere, has also been found to undergo annual changes, increasing from the month of July to the month of November inclusive; so that the greatest intensity occurs in winter, and the least in summer. Both during serene and cloudy weather, the free electricity of the atmosphere is always positive; but during storms, or when it rains or snows, the electricity is sometimes positive and sometimes negative.

On a Process for Covering Copper or Brass with Lead.—By plunging a copper or lead wire in close contact with a bar of tin into a hot alkaline solution of oxide of lead, the wire becomes covered with a layer of lead, while the tin dissolves in the form of an alkaline stannate. M. Haeffely has made use of this reaction to prepare commercial stannate of soda; but the lead is precipitated in a spongy state, whilst immediately on the introduction of a copper wire into the liquid the lead collects on the wire, spreading evenly over it. The layer thus formed adheres sufficiently to allow of the covered copper being made into evaporating apparatus. However, when submitted for some time to the action of heat, the lead becomes detached. Were it possible to render the layer of lead very adherent and not porous, this process would be of great service in the manufacture of chemical products. In evaporating acid liquids, copper vessels lined with lead could be used instead of leaden vessels, their thickness being inconvenient.—*Polytechnisches Centralblatt*, p. 278, 1862.

The Electric Light.—M. Brachet has suggested the enclosing the light in a double globe of glass, the inner one to be of uranium glass, to arrest the chemical rays; the outer glass of a colour which will absorb the greenish hue of light transmitted through uranium. The French Academy have referred the subject to MM. Regnault and Babinet.

To Correspondents.

⁂ We shall be glad of any fragments of telegraphic news which may fall under the notice of any of our correspondents. By communicating the same they may confer considerable benefit on the telegraphic world in general.

C. B.—We shall be happy to insert your communication next week.

B. C.—In reference to your inquiry in No. 46, the specification of the patent in question, dated 10th January 1862, No. 77, can be obtained on application to the Patent Office. Price, exclusive of postage, 1s. 4d.

Antimomus.—We are informed that there is an *erratum* to be made in the paragraph you mention, which should have been—"The inductive discharge upon sixteen miles, with two cells (of Daniell) was 9°; with four cells 23°; and with *eight* cells 45°."

J. H. K.—You have given an *aperçu* of one part only of your electro-magnetic engine, viz., the contrivance for obtaining length of stroke. In principle this is the same as that which has been adopted by Mr. Thomas Allen; but mechanically, we think Mr. Allen's the best arrangement. We hope shortly to give a detailed description of the machine in question. We shall be glad to have further details of the engine you mention, should there be any points of originality in it.

L. R.—Our Agent in Manchester is John Heywood, Deansgate.

D. L.—See an article in the present number. The subject is well worthy of consideration.

W.—The articles you mention commenced in No. 12, Vol. I.

R. C.—Both of the books you refer to are published by Messrs. Lockwood and Co., Stationers' Hall Court, E.C.

James Welch.—We propose, in a future number, to refer to the subject mentioned in your letter.

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The Electrician.

Vol. II. No. 49.—October 10, 1862.

CONTENTS:

	PAGE		PAGE
The Chemical Theory of the Voltaic Couple	265	The Theory of Cylindrical and Spherical Condensers	271
Some Considerations on the Principles of Electrical Conduction and Accumulation	266	Fire Telegraphs on the Continent	272
Electrical Literature	268	Record of the British Association	273
The Galvanic Circuit Investigated Mathematically	270	The Student	274
		Correspondence	275
		Telegraphic News	276
		To Correspondents	276

THE CHEMICAL THEORY OF THE VOLTAIC COUPLE.

[Continued from page 253.]

It will be understood that several of the statements put forward in the article contained in our last number, are open to question and discussion, not alone on the part of those who may still maintain some of the positions adopted and defended by Pfaff, Marianini, Fechner, Zamboni, and Ohm, as advocates of the contact theory, but by those also who, recognize the conclusiveness of the experimental demonstrations of Peltier, Becquerel, De La Rive, Faraday, and others, who have maintained that chemical action is the only demonstrated source of the power of the battery. By placing in a somewhat controversial light the facts to which these statements refer, we may expect to serve a useful purpose, by preventing their being received by the electrical student without some examination, or by showing with what degree of reservation they may be accepted.

Owing to the causes to which we have imperfectly glanced, the action of the zinc-copper couple of Volta rapidly decreases when the elements are connected by a conductor offering but small resistance, and the electro-motor is also found to lose its power, but more gradually, when the external resistance is considerable. The distinction between the two cases is of some importance; for the question arises, *whether the oxidation of the hydrogen evolved at the negative pole of the couple has any direct effect in reducing the tension* of the voltaic arrangement.

Indirectly, under ordinary conditions, it is well known to produce this effect. By the solution of the zinc by the acid, the fluid becomes charged with sulphate of zinc, the metal of which, as may readily be shown in a zinc-copper couple which has remained for some period in action, becomes reduced upon the copper element, causing it to assume a condition of negative tension in relation to the fluid of the cell. This effect has been explained by supposing that the nascent hydrogen on the surface of the negative element combines with the oxygen of the metallic base of the salt; the metal being precipitated upon the copper, while the acid is transferred to the zinc. It is more probable, however, that the reduction takes place by direct electrolysis of the salt, as it occurs with greater facility in a neutral solution, where the conductivity of the fluid depends principally upon the presence of the zinc compound. In the other hypothesis we have to encounter the apparent anomaly, which, however, is not without its counterpart in several chemical reactions, that the hydrogen separated from water, in virtue of the affinity of zinc for the oxygen of this compound, possesses the power of *decomposing* the oxide of the metal. It may here be observed that the opinion, at one time generally entertained, that the decomposition of metallic and other salts, is, in all cases, a secondary effect of voltaic action, appears completely disproved by the experiments of M. D'Almeida,* and by the electro-decomposition of anhydrous salts in a state of fusion.

* "Bibliothèque Universelle de Genève," t. xxix. p. 5.

If we allow that the film of hydrogen gas adhering to the polarised negative plate is exactly analogous to a deposit of reduced zinc, and differs in its action from the latter merely in the fact of possessing a lower degree of affinity for the oxygen of the fluid, we are forced to admit that it must necessarily also reduce the difference of tensions in the elements of the couple.

An *a priori* theoretical objection to this view is found in the fact that the film of hydrogen essentially differs from the zinc deposit in its non-conducting property, to which is attributable, in great measure, the very considerable reduction in the *quantity* of electricity traversing the circuit, which takes place when the zinc-copper couple has been for some period in action. Another objection, based upon grounds of experiment, may perhaps be brought forward, subject to the snbsequent confirmation or disproval of other experimenters. It has been found that the *tension* of a water-battery of zinc and copper elements, measured upon the electrometer, is at least equal to that of a similar battery of Daniell's elements, even when the former had been in dynamic action for several weeks, and therefore exposed to the effect of polarization. Again, it has been stated that when the zinc and copper elements of a couple immersed in *dilute sulphuric acid* were separated by means of a porous diaphragm, the initial tension of the arrangement was preserved for a considerable period. In this case the contact of the negative element with the salt formed by the oxidation of the zinc, and the solution of the oxide, was in great measure prevented.

On these grounds it might be maintained that the effect of the hydrogen which collects upon the surface of the negative element is not necessarily to reduce the *tension* of the voltaic arrangement, though by its non-conducting property, and by its oxidation, it decreases the dynamic effect. This view, however, is not alone in opposition to the generally received chemical theory of voltaic action, which explains the differences in dynamic power observed in various voltaic combinations, but also to the results obtained by experiment with "polarized electrodes."

With the view of throwing some light upon this and other points, we may proceed to examine the theory in question, as expounded by an eminent authority, and to compare the conditions under which the experiments on the polarization of electrodes have been conducted, with those which occur in the polarization of the elements of the voltaic couple.

"In the voltaic couple," says M. Gavarret—who has given the most recent general exposition of this theory, "a conflict of chemical affinities takes place at the surface of contact of the fluid and the zinc plate; on the one side the affinity of hydrogen for oxygen opposes the decomposition of water; on the other, the affinity of zinc for oxygen, and the affinity of sulphuric acid for the oxide of zinc act together to liberate the oxygen, and to cause it to enter into a fresh combination. In this conflict, the molecules of the water become polarized, the affinity of the hydrogen is overcome, water is decomposed, and sulphate of zinc is formed. The acid and the zinc acquire opposite tensions, which become neutralized through the polar conjunction, giving rise to a current in the direction, through the fluid, from the zinc to the copper. * * * * At the moment when it becomes separated from the hydrogen, the oxygen acquires a *negative* tension; there is, therefore, a tendency to the production of a current in the direction *from the fluid* which retains the positive hydrogen *to the zinc*, towards which is carried the oxygen. We know, on the other hand, that the oxidation of zinc and the formation of sulphate of zinc, are two chemical actions which unite to produce a current in the direction *from the metal* acted upon *to the fluid* which yields oxygen. The surface of chemical action becomes, therefore, the seat of two electromotive foaces in contrary directions; the one due to the decomposition of water, the other to the oxidation of zinc, and the solution of its oxide in the acid fluid. The electromotive force of the couple has therefore the same intensity and the same direction as the *resultant* or the *difference* of these partial and opposed electromotive forces. The current which is produced travels, through the fluid, from the zinc to the copper, because the electromotive force arising from the joint influence of the oxidation of zinc and of the solution of the oxide, overcomes the electromotive force due to the decomposition of water."

This explanation of the originating causes of voltaic action

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appears either to be unnecessarily complicated, or not sufficiently explicit. The operation of a current which tends to pass from the fluid to the zinc, is subsequently referred to as due to the polarization of the negative plate, but we are here given to understand that a similar effect is active at the first moment of the generation of voltaic action. According to our view, the positive element acquries its negative charge in virtue of its combination with the electro-negative oxygen, while the liberated hydrogen from the decomposed molecule of water, when the voltaic circuit is complete, occasions the decomposition of a chain of molecules, thus giving rise to electrolytic conduction in the direction of the negative plate. In the simpler explanation we have already given, the nature of the electro-motive force which opposes any neutralization *through the fluid* of the opposite electrical tensions, and the causes which limit the extent to which chemical action takes place, may be clearly understood. Thus, in virtue of its affinity for the electro-negative constituent of water, the electro-positive metal polarizes the molecules of the fluid in every direction, and in such manner that the electro-negative atom is disposed by attraction towards its surface, while the electro-positive atom of hydrogen in each molecule is repelled. Under these conditions, it is impossible for any transfer of electricity to take place from the fluid to the metal—electrolytic conduction in this direction necessitating an opposite polarization of the fluid molecules, or that the positive atom should be turned towards the metal. The nature of the electro-motive force is here sufficiently evident; and we cannot suppose that the chemical action, due to the greater attraction or affinity of oxygen for zinc than for hydrogen, should ever exceed its cause, which results in the polarization of the fluid. No recombination of the separated electricities can then take place. The negative tension of the zinc, and the positive tension of fluid, when the circuit is incomplete, becomes sufficient to counteract their chemical affinity for each other; while, on the other hand, the affinity, or electro-attraction of zinc for oxygen, is always sufficient to maintain the polarization of the fluid, and thus to prevent conduction in the direction from the fluid to the zinc. On this view, it cannot be assumed that, because opposite electrical tensions are produced by the simple separation of the constituents of water, there are, therefore, *two* electro-motive forces generated, tending in opposite directions.

(*To be continued.*)

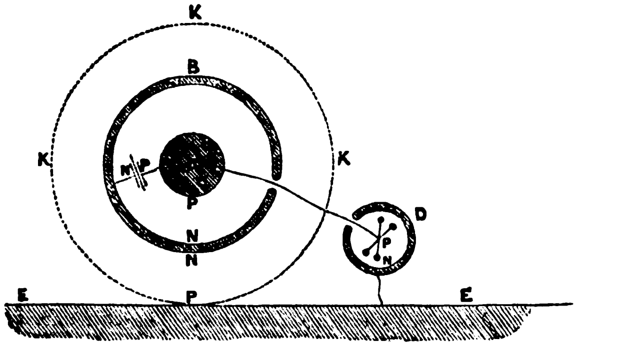
SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 233.]

Suppose, now, A (fig. 95) to be a sphere surrounded by an insulated shell B, and let A be charged positively from one pole of a source, having its negative pole connected to the shell B, then a certain positive quantity will be communicated to the sphere, and an equal negative quantity to the shell, the whole of the latter being resident on the interior of the shell. If, now, A is connected by a wire to the arms of an electrometer, D, the armature of which is connected to the earth, then, since we open a fresh inductive path between the two opposite charges, a redistribution will take place in the inverse ratio of the resistances, separating them in different directions. These resistances are in one direction, the resistance directly between A and B, and in the other, that between the arms of the electrometer and its armature plus the resistance between the earth and the outside of the shell B. This latter resistance is undefined, because we cannot assign to it any dimensions, nor can we tell to what extent induction takes place in curved lines. But if we suppose B surrounded by another shell, K K, connected to the earth, then the problem would have in it nothing indefinite, since all the resistances are clearly defined. The quantity on A would be to that on the arms as the resistance between the arms and armature plus the resistance between B and K, is to that between A and B, all of which are comparable resistances.

Fig. 95.



Thus if R=resistance of electrometer
r =resistance between A and B
r'=resistance between B and K
Q=quantity on A before electrometer was connected
q =quantity on electrometer when connected.

Then $q=\frac{Qr}{r'+R}$

Now, if r is increased, as, for instance, if the conductor A could be reduced in size, the quantity q would increased; or if r' be decreased, as, for instance, if the shell K K be contracted round B, then again q would be increased; or if r is increased, and r' decreased, as, for instance, if the shell B is enlarged, then q will increase. In all these cases the quantity q will measure the tension existing between A and the shell K K, and consequently between A and the earth. If the shell, K K, did not exist, then, still, the resistance between B and the earth would have a certain value, and would be equal to the resistance between B and some shell a little larger than K K.

Suppose, now, the shell B removed, and A to be a sphere charged positively from a source connected with the earth, then, if the arms of the electrometer D be connected to the sphere, and the armature to the earth, then the quantity on A will divide itself with the electrometer in the inverse ratio to the resistances separating A from the earth, and that separating the arms from the armature.

Or if R=resistance of electrometer
r=resistance between A and the earth
Q=the total quantity
q=quantity on electrometer, and to which quantity the tension between A and the earth is proportional.

Then $q=\frac{Qr}{R}$.

Now, r is an undefined resistance, but if we suppose A surrounded by a shell, K K just touching on the earth, then it is evident the resistance between A and K will always be less than that which would exist between A and the earth; for that between A and the earth consists of all the resistance between A and K, plus all that resistance existing between the earth and those parts of K which do not touch the earth. The exact ratio this irregular unbounded resistance has to the distance between A and the earth, it is not easy to determine.

But by a little indirect consideration of the subject we shall see that when the sphere A is more than twenty diameters distant from the surface of the earth, very little resistance is added by moving it any further from the earth; that is, considering the surface of the earth as a practically infinite plane. This may be explained as follows:—

The proportionate resistance of shells of dielectric is, accord-

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ing both to Mr. Longridge and M. Gaugain,* expressed by the formula :—

$$R=\frac{r'-r}{r'\,r}$$

Where R=Inductive resistance of a shell of dielectric comprised between two concentric conducting spherical surfaces, of which

r=Radius of interior surface
r'= „ exterior surface

If r=unity, then $R=\frac{r'-1}{r'}=r'-\frac{1}{r}$

Hence, however great r' may be, R can never equal unity until r' is infinite.

Thus, if $r=1$ and $r'=2$ then $R=\frac{2-1}{2}=\frac{1}{2}=0{\cdot}5$

If $r=1$ and $r'=20$ $R=\frac{20-1}{20}=\frac{19}{20}=0{\cdot}95$

If $r=1$ and $r'=10{,}000$ $R=\frac{10{,}000-1}{10{,}000}=0{\cdot}9999$

Hence it appears, that when a conducting sphere A is surrounded by a conducting shell, K K K, of twice the diameter of the sphere, the inductive resistance of the shell of dielectric between the two is one-half of that which would result by replacing the surrounding shell, K K K, by one having an infinite diameter. And when the diameter of the shell, K K, is twenty times that of the sphere A, the inductive resistance between the two is within 0·05 of that which would be produced by replacing K K K by an exterior shell of infinite diameter.

Now, the indefinite resistance between the shell K K, and the flat surface, E E, of the earth, cannot be so great as that between K K and an infinite exterior shell, since the flat surface, E E, actually touches on K K at one point, therefore the resistance of this indefinitely-shaped resistance is less than—

1—R, or 1—0·95, or 0·05.

Therefore, the difference between the resistance produced by enveloping A with a complete conducting shell, K K K, twenty times the diameter of the sphere A, and that produced between A and the flat surface of the earth, is only some quantity less than 1-20th of the resistance between A and the conducting shell, K K.

Therefore, when a sphere is situated a distance equal to 20 times its radius above the earth (or a sphere 1 foot diameter having its centre situated 10 feet above the earth), the quantity that would be accumulated on it from one pole of a given source, having its other pole connected to the earth, would be within less than a twentieth part of that which would be accumulated on it if it were completely enveloped by a conducting shell (connected to earth) having a radius equal to the distance of the centre of the sphere to the earth, *i. e.*, 10 feet.

And conversely, if the sphere be charged with a given quantity its tension to the earth would be less than a twentieth part greater, when unsurrounded by the shell K K, than when it was so surrounded. Finally, the tension of the sphere A to the earth would be, if surrounded by the shell K K, within 1-20th of the maximum tension it could possibly attain with that quantity. And, if unsurrounded, it would be still a little nearer to its maximum tension.

If we consider a sphere placed a distance equal to a great many times its diameter above the earth, or if we consider it in a very large chamber, so that r', in the formula $R=\frac{r'-r}{r'\,r}$, may be considered practically infinite, as compared to r, then R becomes inversely proportional to r.

Thus if $r=1$ and $r'=100$ then $R=\frac{100-1}{100}=\frac{99}{100}=0{\cdot}99$

If now $r=2$ then $R=\frac{100-2}{100\times 2}=\frac{98}{200}=0{\cdot}49$

and if $r=3$ then $R=\frac{100-3}{100\times 3}=\frac{97}{300}=0{\cdot}32$

The greater r' is compared to r, the nearer will the inductive resistance become inversely proportional to the radii of the spheres.

Hence, the quantity accumulated on a sphere situated far from all surrounding conductors, from one pole of a given source having its other pole connected to the surrounding surface, will be *directly* proportional to its radius. And conversely with a given quantity, the tension between a sphere and the surrounding surface will be *inversely* proportional to its radius.

And if two spheres of different diameters separated a great distance from one another be connected by a fine wire, and a charge imparted to them, the quantities on these spheres will be to one another as the radii of the spheres.

And since D, the density is equal to $\frac{Q}{S}$, and Q is proportional to r and S to r^2, D is proportional to $\frac{r}{r^2}$, and, consequently, inversely proportional to r. Or the densities will be inversely as the radii of the spheres.

To give a final example of these rules; suppose two spheres, A and B, situated far from one another, and from all surrounding conductors.

Let r =radius of A=2
„ r'= „ B=3
„ R inductive resistance of A to surrounding conductors =12
Then R′ inductive resistance of B to surrounding conductors $=\frac{Rr'}{r}=8$

If a quantity Q=100 be imparted to A, and A and B be now joined by a conducting wire, then this quantity will distribute itself on the two spheres inversely as the resistances R and R′, or, in fact, directly as r and r'.

* In the appendix to this work, Mr. Longridge's investigation of the resistance of shells and cylinders of dielectric, according to Ohm's law, and based on the formula $R=\frac{L}{S}$, for prismatic resistances will be given.

This investigation gives the formula for the resistance of a shell of dielectric

$$R=\frac{C}{8\,\pi}\cdot\frac{D-d}{D\,d}.$$

Where R = Resistance
D = Outer diameter of shell
d = Inner „ „
C = Co-efficient of resistance, or resistance of a prism of dielectric of a unit of of length and unit of surface.
π = 3·1416.

This formula gives the absolute resistance of a shell of dielectric, as compared to that of any prism of which the dimensions are known. But if we wish to treat simply of the proportionate resistance of shells of dielectric to one another, then the co-efficient C, and constant 3·1416, may be neglected, and the formula becomes $R=\frac{D-d}{D\,d}$.

And since D is always proportional to the radius

$$R \text{ also } =\frac{r'-r}{r'\,r}.$$

Now it has been shown that the quantity from a given constant source is inversely proportional to the resistance of the inductive circuit. Hence if a shell of dielectric be the sole resistance of the circuit (which would be the case if a sphere be attached to one pole of a source, the other pole of which is attached to an outer spherical armature), the quantity generated will be expressed by

$$Q=\frac{r'\,r}{r'-r}.$$

This is just what has been expressed in words by M. Gaugain, in his "Note on Spherical Condensers," in the *Philosophical Magazine* for March, 1862.

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Hence, q, or quantity, on $A=\frac{QR'}{R+R'}=40$

q, or quantity, on $B=\frac{QR'}{R+R'}=60$

T tension of A to surrounding conductors$=R\,q=12\times40=480$
T′ „ „ „ $=R'q'=\ 8\times60=480$

showing that by the formula $T=QR$, the tension of each to the common surrounding conductors is the same, and, consequently, that the two are in equilibrium.

And the densities will inversely as the radius. This latter deduction is easily proved by simply finding the surface of the spheres and dividing the quantities previously found by the surfaces, thus:—
S or surface of $A=(2\,r)^2\pi=\ 50{\cdot}26$
S′ „ $B=(2\,r)^2\pi=113{\cdot}09$

Therefore D density on $A=\frac{q}{S}=\frac{40}{50{\cdot}26}=0{\cdot}79$

and D′ „ $B=\frac{q'}{S'}=\frac{60}{113{\cdot}09}=0{\cdot}53$

Now 79 : 53 : : 3 : 2
or $D : D' : : r' : r$
or the densities are inversely as the radii of the spheres.

The results thus obtained by this simple mode of considering problems of accumulation agree strictly with those deduced from the more comprehensive, but, at the same time, infinitely more intricate mathematical theory of Green; and as that theory is one which is always spoken of in the most eulogistic terms by Professor Thompson, one of our highest mathematical authorities, the coincidence between the results obtained by the two modes of considering the same problem is not unimportant, and will be, perhaps, evidence in favour of the soundness of the views I have set forth.

(To be continued.)

ELECTRICAL LITERATURE.

A complete catalogue of books, papers, and articles on Electricity, &c., is a desideratum, and would, no doubt, tend equally towards the advancement of electrical knowledge, and the history of its progress; and, we have no doubt, that many of our readers will be glad of, and take great interest in, such a compilation. With this view, we commence a list of all works, or pamphlets, that have come to our knowledge on electricity, magnetism, and the electric telegraph, and of works which contain articles on any of these subjects. We begin with a list of Mr. Latimer Clark's extensive library, with which he has most kindly furnished us. This rare and comprehensive collection, comprising about four hundred volumes and pamphlets, must, as our readers will soon perceive, have cost an amount of patience, labour, and expense to collect, which none but a true lover of the science and history of Electricity would be likely to bestow on it. We are also indebted to Mr. F. C. Webb for the care and trouble he has taken in compiling and arranging the catalogue, and, indeed, for suggesting and organising its publication. We shall publish a portion of the catalogue each week, until complete, and it will be afterwards printed on one side of the leaf only, in book form, and sold separately, so that those who desire to form complete catalogues of electrical works, may be able to cut the title of each work out separately, and paste them into books, and add to them as the names of fresh works of old date are obtained. Such a work will be of immense value to those who seek reference to works on electricity at the reading rooms of the British Museum, since there exists no catalogue, *raisonnée*, at that institution, so that, unless the reader seeks for some particular work of which he knows, not only the title, but the author's name, it is nearly impossible to obtain it. We trust that all our subscribers will endeavour to assist us in this important work, by sending to us the names of any books on electricity, &c., that may not be contained in Mr. Latimer Clark's very complete list. In doing this, we shall feel obliged if they will always give the *complete title pages*, so that we may be enabled to reproduce the name of each book in the same form as those we now publish, and thus preserve the uniformity of the whole. If our endeavours meet with the approval and co-operation of our subscribers, we shall endeavour to give complete lists of the papers on electricity that have appeared from the earliest dates in—

1. Philosophical Transactions of the Royal Society.
2. Proceedings of the Royal Institution.
3. Comptes-rendus a l'Academie des Sciences.
4. Reports of the British Association for the Advancement of Sciences and Transactions of the Sections.
5. Proceedings of the Institution of Civil Engineers.

To which we shall add a list of the articles on electricity, &c., that have appeared in:—

1. The Philosophical Magazine.
2. Scientific Memoirs.
3. Journal of the Society of Arts.
4. Annales de Chimie.
5. A list of the Parliamentary Blue Books on Electric Telegraphs, &c.

We publish, also, now, the names of two foreign periodicals, exclusively devoted to Electricity and the Electric Telegraph.

LIST OF CURRENT PERIODICALS ON ELECTRICITY AND THE ELECTRIC TELEGRAPH.

[Zeilpchrift des Deutsch—österreichischen Telegraphen-Veriens Herausgegeben in dissen Auftrage von der Königlich Preussischen Telegraphen-Direction. Redigist von Dr. P. Wilhelm Brix.—Berlin: Verlag von Ernst and Korn.]—4to., with folding plates. Appears irregularly, about 10 or 12 numbers in the year.

[Annales Télégraphiques publiées par un comité composé de fonctionnaires de l'administration des Lignes Télégraphiques.—Paris: Chez Dalmont et Dunod, Editeurs precedemment Carilian Gœury et Victor Dalmont Libraires des corps Impériaux des Ponts et Chaussées et des mines. Quai des Augustins, 49.]—8vo., with folding plates, published in bi-monthly parts.

CATALOGUE

OF BOOKS AND PAMPHLETS ON ELECTRICITY, GALVANISM, MAGNETISM, ELECTRO-MAGNETISM, MEDICAL ELECTRICITY, ATMOSPHERIC ELECTRICITY, ELECTRO-TELEGRAPHY, ETC., AND OF BOOKS ON NATURAL PHILOSOPHY, ENCYCLOPÆDIAS, AND BOOKS OF REFERENCE, CONTAINING CHAPTERS OR ARTICLES ON THESE SUBJECTS, WITH DATES, AUTHORS NAMES AND IMPRINT, ARRANGED CHRONOLOGICALLY.

With the size of the book, number of volumes, when more than one, and (in most cases) the number of pages, with occasional notes on those books which are rare or contain anything of peculiar interest. In the case of those books of which a portion only treats of electricity, &c., the pages between which, or chapters in which, these subjects are contained are given.

The works are arranged according to the year of publication, but those published in the *same* year are placed promiscuously, as it is only in a very few cases that the *month* of publication is given in the preface or title.

The letter press between the parenthesis is (except in those cases marked thus ‡), a full copy of the title page of the work, with the exception of poetical and prose extracts and quotations which occur on some, the reproduction of which could serve no purpose.

The imprint and publisher's names are given in full, in order that those

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who are desirous of obtaining any old work may have every possible clue towards the attainment of their object.

No notice is taken in this list of current periodicals, or the transactions of scientific societies, but a few periodicals on Electricity, which have been discontinued (such as "Sturgeon's Annals of Electricity") are given as complete works.

1578—Norman, Robert.—

[Newe Attractive.]

The earliest work on the Magnet, in which the dip of the needle is first alluded to.

1600—Gilbert, William.—

[Guilielmi Gilberti Colcestrensis medici Londinensis. De magneti, magneticisque corporibus et de magno Magneti Telluri. Physiologia nosia, plurimis et argumentis et experimentis demonstrata.—Londoni: Excudibat Petrus Short, Anno. MDC.]—4to., numerous wood-cuts.

After the address to the reader, is a parenthesis by Edward Wright, in which Drake, Candish, Linschoten, Hakluyt, and the Voyage to the Azores are noticed. This work is most valuable for the history of Science, and was highly prized both by Galileo and Humboldt. Probably the first book written on electricity. Gilbert, famed for his learning, depth in philosophy, and admirable skill in chemistry, became one of the members of the College of Physicians in London, and Physician in Ordinary to Queen Elizabeth, who had so high a value for him, that she allowed him an annual pension to encourage his studies.

1613—Redley, Dr. Marke.—

[A short treatise on Magnetical Bodies and Motions. By Marke Ridley, Dr. in Physic and Philosophy, lately Physition to the Emperour of Russia, and one of ye eight principal Elects. of the College of Physitions in London.—London: printed by Nicholas Okes, 1613.]

1616—Barlow, Timothy.—

[Magnitical Advertisments, or Dwer's pertinent observations and approved experiments on the nature and property of the Load Stone. Very pleasant for knoledge, and most needful for practice of travelling, of framing of instruments fit for travelling, both by sea and land.—London: printed by Edward Griffin for Timothy Barlow, and are to be sold in his shop in Paul's Church Yard, at the sign of the Bull's Head, 1616.]

1629—Nicolas Cabeo.—

[Philosophia Magnetica in qua Magnetis natura penitus explicatur at omnium quae hoc Lapide cernimtur cause propriea asseruntur. Nova Etiam Pyxis constructur que propream Poli Elevationem Cum suo meridiano ubique demonstrat. Multa quoque Decumtur de electricis et alijs attractiombus et corum causis Autore. Nicolao Cabeo, Ferrariensi, Soc. Jesu, Ferrarie apud Franciscum Succium superiorum permissu, 1629.]—4to., illustrated.

1654—Kercheri, Athomasii.—

[Athomasii Kercheri Societatis Jesu: Magnes Sius de Arte Magnetica opus Tripartitum quo Umversa Magnetis Natura eiusque in omnibus Scientijs et Artibus issus nova methodo explicatur ac preterae e veribus et prodigiosis effectebus magneticarum aliarumque abditarum. Natura motionum in elementis Lapedibus Plomtis Animalibus eluceseentium mula hucusque incognita Natura areana omnes generis experimenta recluduntur. Editio Tertia Ab ipso Antore recognita emendataque ac multes nouorum. Experimentorum problemates aucta.—Rome, MDCLIV. Sumptibus Blasij Deuersia et Zanobij Masotte. Bibliopolarum Typis Vilatis Mascardi superiorum permissu et Privilegijs.]—4to.

1664—Power, Henry.—

[Experimental Philosophy in three books, containing

New Experiments... { Microscopical, Mercurial, Magnetical;

with some deductions and probable hypotheses raised from them in avouchment and illustration of the new famous atomical hypothesis. By Henry Power, D. of Physick.—London: printed by T. Roycross, for John Martin and James Allesby, at the Bell in St. Paul's Church-yard, 1664.]—8vo., plate.

1672—Guericke, Otto.—

[Ottonis de Guericke Experimenta nova (ut vocantur) Magdiburgica de vacuo spatio. Primum a R.P. Caspore Schotto è Societate Jesu a Herbipolitanæ Academiæ Mathesios Prefessore: nunc vero ab ipso auctore Perfectius edita, rariisque aliis experimentis aucta. Quibus accesserunt simul certa quædam De aeris Pondere circa Terram; de virlulibus mundamis, systemale mundi Planetasio; sicus et de Stellis Fixis ac spatio illo Immenso, quod tam intra quam extra eas funditur. Amstelodami. Apud Soannem Sanssonium à Waesberge, anno 1672. Cum privilegio, S. Cæf Majustatis.]—Large 4to., wood-cuts.

Contains: Libri quarti chap. xv. De experimento quo præcipua hæ virtutes enumeratæ per attritum in Globo Sulphureo excitari possunt, page 147.

A great part of this work is devoted to descriptions of experiments with the *air pump*, which was invented by Otto Guericke. He also constructed the first rotating electrical machine, consisting of a Globe of Sulphur, experiments with which are described in this volume. He also speaks of the spots on the sun.

1684—Waller, Richard.—

[Essayes of Natural Experiments made in the Academie del Cimento, under the protection of the most Serene Prince Leopold of Tuscany; written in Italian, by the Secretary of that Academy. Englished by Richard Waller, Fellow of the Royal Society.—London: printed for Benjamin Alsop, at the Angel and Bible, in the Poultry, over against the Church, 1684.]—8vo., plates.

Contains, page 123, Experiments Magnetical; page 128, Experiments touching Ambre, and other Electric bodies.

1691—Boyle, Hon. Robt.—

[Experimenta & Observationes Physicæ, wherein are briefly treated of several subjects relating to Natural Philosophy in an experimental way. To which is added a small collection of Strange Reports, in two parts. By the Honourable Robert Boyle, Fellow of the Royal Society.—London: printed for John Taylor, at the *Ship*, and John Wyat, at the *Rose*, in St. Paul's Church-yard, MDCXCI.]—12mo., 158 pages and 25 pages.

Contains—Tomi, 1, Chapt. 1. Chymico Magnetical Experiments and Observations. At page 41, he alludes to the "Electrical virtue" of diamonds.

1699—Boyle, Hon. Robert.—

[The works of the Honourable Robert Boyle, Esq., epitomiz'd. By Richard Boulton, of Brazennose College, in Oxford. Illustrated with copper plates.—London: printed for F. Phillips, at the King's Arms, and F. Taylor, at the Ship, in St. Paul's Church-yard, MDCXCIX.] In four volumes.

Contains in Vol. II., Book III., Chap. XXII., of the Celestial and Aerial Magnets. Chap. XXIII., Experiments and Notes about the Mechanical Production of Magnetical Qualities. Chap. XXIV. Chymico-Magnetical Experiments and Observations. Chap. XXV. Experiments and Notes about the Mechanical Origin and Production of Electricity.

It is announced that the United Kingdom Company have let the contracts for their lines from London to Leeds, Hull, and Glasgow, and that the works are already in progress.

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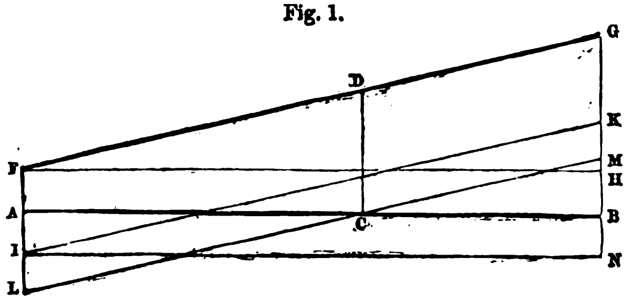
THE GALVANIC CIRCUIT INVESTIGATED MATHEMATICALLY.

BY DR. G. S. OHM.

[Continued from p. 259.]

The mode of separation of the electricity has been completely determined by the preceding observation; but the absolute force of the electricity at the various parts of the ring still remains uncertain. This property may be best conceived, by imagining the ring, without its nature being altered, opened at the point of excitation and extended in a straight line, and representing the force of the electricity at each point by the length of a perpendicular line erected upon it; that directed upwards may represent a positive electrical, but that downwards a negative electrical state of the part. The line A B (fig. 1), may accordingly represent the ring extended in a straight line, and the lines A F and B G perpendicular to A B, may indicate by their lengths the force of the positive electricities situated at the extremities A and B. If now the straight line F G be drawn from F

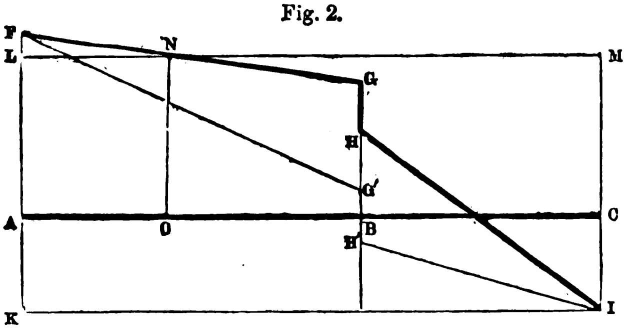
Fig. 1.



to G, also F H parallel to A B, the position of F G will give the mode of separation of the electricity, and the quantities B G — A F or G H the tension occurring at the extremities of the ring; and the force of the electricity at any other place C, may easily be expressed by the length of C D drawn through C perpendicularly to A B. But, from the nature of the galvanic excitation, merely the quantity of the tension or the length of the line G H, therefore the difference of the lines A F and B G, is determined, but not at all the absolute magnitude of the lines A F and B G; consequently, the mode of separation may be represented quite as well by any other line parallel to the former, *e. g.* by I K, for which the tension still constantly retains the same value expressed by K N, because the ordinates situated at present below A B assume a relation opposed to their former one. Which of the infinitely numerous lines parallel to F G would express the actual state of the ring cannot be stated in general, but must in each case be separately determined from the circumstances which occur. Moreover, it is easily conceived that, as the position of the line sought is given, it would be completely determined for one single part of the ring by the determination of any one of its points, or, in other words, by the knowledge of the electric force. If, for instance, the ring lost all its electricity by abduction at the place C, the line L M drawn through C parallel to F G, would in this case express with perfect certainty the electrical state of the ring. This variability in the separation of the electricity is the source of the changeableness of the phenomenon peculiar to the galvanic circuit. I may further add, that it is evidently quite indifferent whether the position of the line F G, with respect to that of A B, be fixed; or whether the position of the line F G remain constantly the same, and the position of A B with respect to it be altered. The latter course is by far the more simple, where the separation of the electricity assumes a more complex form.

The conclusions just arrived at, which hold for a ring homogeneous throughout its whole extent, may easily be extended to a ring composed of any number of heterogeneous parts, if each part be of itself homogeneous, and of the same thickness. I may here take as an example of this extension a ring composed of two heterogeneous parts. Let this ring be

Fig. 2.



imagined, as before, open at one of its places of excitation, and stretched out to form the right line A B C (fig. 2), so that A B and B C indicate the two heterogeneous parts of the ring. The perpendiculars A F, B G, will represent by their lengths the electrical forces present at the extremities of the part A B; on the other hand, B H and C I, those present at the extremities of the part B C; accordingly, A F + C I or F K will represent the tension at the opened place of excitation, and G H the tension occurring at B at the point of contact. Now if we only bear in mind the permanent state of the circuit, the straight lines F G and H I will, from the reasons above mentioned, indicate by their position the mode of separation of the electricity in the ring; but whether the line A C will keep its place, or must be advanced further up or down, remains uncertain, and can only be found out in each distinct case by other separate considerations. If, for instance, the point O of the circuit is touched abductively, and thus deprived of all electricity, O N would disappear; and therefore the line L M drawn through N, parallel with A C, would in this case give the position of A C required. It is hence evident, how sometimes this, sometimes another, position of the line A C in the figure F G H I, representing the separation of the electricity, may be the one suited to the circumstances; and herein we recognise the source of the variability of galvanic phenomena already mentioned.

It is, however, essentially requisite, in order to be able to judge thoroughly of the present case, to attend to a circumstance, the mention of which has hitherto been purposely avoided, that the various considerations might be separated as distinctly as possible. The distances F K and G H are indeed given by the tensions existing at the two places of excitation, but the figure F G H I, is not yet wholly determined by this alone. For instance, the points G and H might move down towards G′ and H′, so that G′ H′ would equal G H, giving rise to the figure F G′ H′ I, which would indicate quite a different mode of separation of the electricity, although the individual tensions in it still retain their former magnitude. Consequently, if that which has been stated with respect to the circuit of two members is to acquire a sense no longer subject to any arbitrary explanation, this uncertainty must be removed. The first fundamental law effects this in the following way:—For since the state of the ring alone, independent of the time, is regarded, each section must, as has already been stated, receive in every moment the same quantity of electricity from one side as it gives off to the other. This condition occasions upon such portions of the ring as have perfectly the same constitution at their various points, the constant and uniform change in the separation which is represented in the first figure by the straight line F G, and in the second by the straight lines F G and H I. But when the geometrical or the physical nature of the ring changes in passing from one of its component parts to another, the reason of this constancy and uniformity no longer obtains; consequently, the manner in which the several straight lines are combined into a complete figure, must first be deduced from other considerations. To facilitate the object, I will separately consider the geometrical and physical difference of the single parts, each independently.

Let us first suppose that every section of the part B C is *m* times smaller than in the part A B, while both parts are composed of the same substance; the electric state of the ring, which is independent of time, and which requires that everywhere throughout the entire ring just as much electricity be received on one side as is given off from the other, can evidently only exist under the condition that the electric transition from one particle to the other, in the same time within the portion B C is *m* times greater than in the portion A B; because it is only in this manner that the action in both parts can maintain equilibrium. But in order to produce this *m* times greater transition of the electricity from element to element, the electrical difference of element to element within the portion B C must, according to the first fundamental position, be *m* times greater in the portion A B; or when this determination is transferred to the figure, the line H I must sink *m* times more on equal portions, or have an *m* times greater "dip" than the line F G. By the expression "dip" (*Gefälle*), is to be understood the difference of such ordinates which belong to two places distant one unit of length from each other. From this consideration results the following rule: The dips of the lines F G and H I in the portions A B and B C, composed of like substance, will be inversely to each other as the areas of the sections of these parts. By this the figure F G H I is now fully determined.

When the parts, A B and B C, of the ring have the same section, but are composed of different substances, the transition of the electricity will then no longer be dependent solely on the progressive change of electricity in each part from element to element, but, at the same time, also on the peculiar nature of each substance. This difference in the distribution of the electricity, caused solely by the material nature of the bodies, whether it have its origin in the peculiar structure or in any other peculiar state of the bodies to electricity, establishes a distinction in the electrical conductibility of the various bodies; and even the present case may afford some information respecting the actual existence of such a distinction, and give rise to its more accurate determination. In fact, since the ring, composed of the two parts A B and B C, differs from the homogeneous one only in this respect, that the two parts are formed of two different substances, a difference in the dip of the two lines, F G and H I, will make known a difference in the conductibility of the two substances, and one may serve to determine the other. In this way we arrive at the following position, supplying the place of a definition: In a ring consisting of two parts, A B and B C, of like sections, but formed of different substances, the dips of the lines, F G and H I, are inversely as the conducting powers

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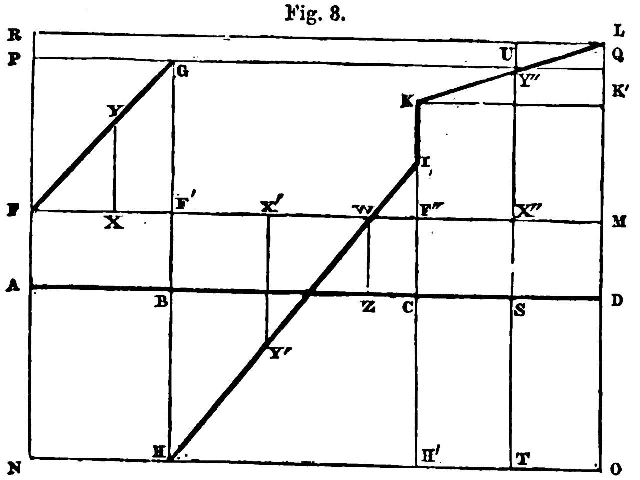
of the two parts. If we have once ascertained the conducting powers of the various substances, they may be employed to determine the dips of the lines, F G and H I, in every case that may occur. By this, then, the figure, F G H I, is entirely determined. The determination of the conductibility from the separation of the electricity is rendered very difficult from the weak intensity of galvanic electricity, and from the imperfection of the requisite apparatus; subsequently, we shall obtain a more easy means of effecting this purpose.

From these two particular cases we may now ascend in the usual way to the general one, where the two prismatic parts of the ring neither possess the same section, nor are constituted of the same substance. In this case the dips of the two parts must be in the inverse ratio of the products of the sections and powers of conduction. We are hereby enabled to determine completely the figure, F G H I, in every case, and also to distinguish perfectly the mode of electrical separation in the ring. All the peculiarities, hitherto considered separately, of the ring composed of two heterogeneous parts, may be summed up in the following manner: In a galvanic circuit consisting of two heterogeneous prismatic parts, there takes place, in regard to its electrical state, a sudden transition from the one part to the other, at each point of excitation, forming the tension there occurring, and from one extremity of each point to the other a gradual and uniform transition; and the dips of these two transitions are inversely proportional to the products of the conductibilities and sections of each part.

Proceeding in this manner, we are able, without much difficulty to inquire into the electrical state of a ring composed of three or more heterogeneous parts, and to arrive at the following general law: In a galvanic circuit consisting of any indefinite number of prismatic parts, there takes place, in regard to its electrical state at each place of excitation, a sudden transition from one part to the other, forming the tension there prevailing, and within each part a gradual and uniform transition from the one extremity to the other; and the dips of the various transitions are inversely proportional to the products of the conductibilities and sections of each part. From this law may easily be deduced the entire figure of the separation for each particular case, as I will now show by an example.

Let A B C D (fig. 3) be a ring composed of three heterogeneous parts,

Fig. 3.



open at one of its places of excitation, and extended in a straight line. The straight lines, F G, H I, K L, represent by their position the mode of separation of the electricity in each individual part of the ring, and the lines, A F, B G, B H, C I, C K, and D E, drawn through A, B, C, and D perpendicular to A D, such quantities that G H, K I and L M, or D L —A F, show by their length the magnitude of the tensions occurring at the individual places of excitation. From the known magnitude of these tensions, and from the given nature of the single parts, A B, B C, and C D, the figure of the electrical separation has to be entirely determined.

If we draw straight lines parallel to A D, through the points F, H, and K, meeting the line drawn through B, C, and D, perpendicular to A D, in the points F', H', K', then, according to what has already been demonstrated, the lines G F', I H', and L K, are directly proportional to the lengths of the parts A B, B C, and C D, and inversely proportional to the products of the conductibility and section of the same part, consequently the relations of the lines G F', I H', and L K', to each other are given. Further, that $GF'+IH'+LK'=GH-KI+(DL-AF=LM)$ is also known, as the tensions represented by G H, K I, and D L—A F are given. From the given relations of the lines, G F', I H', L K', and their known sum, these lines may now be found individually; the figure, F G H I K L, is evidently, then, entirely determined. But the position of this figure with respect to the line A D remains from its very nature still undecided.

If we recollect, that proceeding in the same direction A D, the tensions represented by G H and D L—A F or L M indicate a sudden sinking of the electric force at the respective places of excitation, that represented by I K, on the contrary, a sudden rise of the force; and that tensions of the first kind are regarded and treated as positive quantities, while tensions of the latter kind are considered as negative quantities, we find the above example lead us to the following generally valid rule:—If we divide the sum of all the tensions of the ring composed of several parts into the same number of portions which are directly proportional to the lengths of the parts, and inversely proportional to the products of their conductibilities and their sections, these portions will give in succession the amount of gradation which must be assigned to the straight lines belonging to the single parts, and representing the separation of the electricity; at the same time the positive sum of all the tensions indicates a general rise; on the contrary, the negative sum of all the tensions a general depression of those lines.

THE THEORY OF CYLINDRICAL AND SPHERICAL CONDENSERS.

In the preliminary notice to the first part of Mr. F. C. Webb's work on "Electrical Accumulation and Conduction" just republished from our columns in book form, reference is made to two papers by M. Gaugain, which appeared in the *Philosophical Magazine.* These papers appear to us of considerable importance, as they point out the application of Ohm's laws to certain problems of electro-statics, an application which has hitherto formed the subject of Mr. Webb's contributions to this journal, and which he has treated in considerable detail, and at the same time somewhat differently to M. Gaugain. It is observed by Mr. Webb in the preliminary notice which we have mentioned, that "the importance of this mode of dealing with problems relating to accumulation is at present scarcely appreciated." We wish to afford every facility for the development of this branch of electrical theory, which appears worthy of full consideration; and we therefore this week reproduce one of the papers in question, to be followed next week by the remaining paper.

ON THE THEORY OF CYLINDRICAL CONDENSERS.

BY M. S. M. Gaugain.

Philosophical Magazine, June, 1861. Vol. XXI. Page 539.

I have in a former note* called attention to the fact, that it is very difficult to analyse the phenomena of condensation produced in submarine telegraph cables, the gutta percha which envelopes them being only imperfectly non-conducting, so that there is at one and the same time propagation by conductibility and condensation.

To study the latter phenomenon by itself, I substituted for gutta percha dielectrics, which isolate much more perfectly, I employed for this purpose, gum lac and air; with gum-lac the absorption is very small, with air it is nothing or altogether imperceptible.

The laws which I have succeeded in establishing are very simple, and may be of some practical utility since they afford a solution of the different questions which relate to electric condensation in submerged cables; it is, however, from a philosophical point of view that they seem to be of the greatest interest, since they confirm in a remarkable manner the views of Faraday. This illustrious physicist in a memoir published in 1837 (Experimental Researches, Series xi. No. 1320) explained himself nearly as follows:—"The power of insulating and that of conducting are only two extreme degrees of the same property, and ought to be considered as being of the same nature in any satisfactory mathematical theory." Now it will be seen that, in the case, at least of cylindrical condensers, the laws which regulate the propagation of electricity by *excitation,* do not differ from those which Ohm has established for propagation by conductibility, the general result of my researches may be stated shortly as follows:—

1. When the internal cylinder is the collector, that is to say, when it communicates with the source, and the external cylinder communicates with the ground, the *excited* charge of the external cylinder is equal to the *exciting* charge of the internal cylinder.

2. When the external cylinder is the collector, the *excited* charge of the internal cylinder is precisely the same as it would have been if it had been put in direct communication with the same source.

3. When the external cylinder is the collector, its charge may be considered as consisting of two parts, one of which is equal to the *excited* charge of the internal cylinder, the other representing the quantity of electricity which the external cylinder would take up by itself, under the influence only of the medium in which it is placed.

The latter law enables us to foresee what would happen in the case

* Comptes Rendus 28th October 1860.

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of a condenser formed of three concentric cylinders. The charge which the middle cylinder would take up when put in communication with the source, the other two being connected with the ground, must be equal to the charge which would be excited in it by the two other cylinders. I have found, by experiment, that this is really the case.

It follows, that condensers arranged in a spiral form, may serve to to collect in a small volume a large quantity of electricity.

4. If we agree to call by the name of *resistance to excitation*, a quantity inversely proportional to the charge received by either armature, when the tension of the internal cylinder is maintained at unity, and that of the external cylinder at zero, then this resistance, which I shall call p, is expressed by the formula—

$$p=k\log.\frac{R}{r}$$

R and r representing the respective radii of the external and internal cylinders, and k being a constant, which depends on the inductive capacity of the dielectric, and on the length of the cylinder employed.

This formula is remarkable, since it might have been deduced, *à priori*, from the ordinary theories of propagation by conductibility.

Suppose, in fact, that the substance which separates the two cylindrical armatures of the condensers possesses a certain conductibility, and let us call by the name of *resistance to conductibility*, a quantity inversely proportional to the amount of electricity, which, in a unit of time, traverses the annular space between the cylinders, the tension of the internal cylinder being maintained at unity, that of the external cylinder at nothing. This *resistance to conductibility* may be calculated according to the principles established by Ohm, and it will be found that it is expressed by the same formula as the *resistance to excitation*. To pass from one formula to the other, it is only necessary to change the meaning of k. We may say, therefore, that the same theory—that, namely, of Ohm, regulates propagation by excitation, and propagation by conductibility, at least when we confine ourselves to the consideration of spaces bounded by concentric cylinders. I propose to verify this principle under other circumstances, and especially in the case of spherical condensers.—*Comptes Rendus*, Feb. 18th, 1861.

ELECTRIC FIRE TELEGRAPHS ON THE CONTINENT.

The following is a translation of a description of the electric fire telegraph at Stutgard:—

This telegraph was first proposed by, and carried out from the plans, and under the superintendence of the telegraph-inspector, Geiger. In its use it serves a double purpose:—First, to give timely notice to the parties immediately interested of the outbreak of a fire; secondly, to enable the Police Board to exercise a control, by day and night, over the fire watchmen stationed on the watch towers.

The wires have their central point in the City Police Office, and extend from thence to the tower of the cathedral (Stiftskirchenthurm), and the Infirmary Church Tower (Spitalkirchenthurm), which constitute the first telegraph circle. From thence they extend to the Royal Town Administration Office, the Town Hall, Guard-room, the dwelling of the Commander of the Fire Brigade, the Barracks, and the Chief Guard-house, which constitute the second telegraph circle.

At the City Police Office are placed the electrical battery, the alarm, the keys (similar to the manual of a pianoforte), and the printing apparatus upon Morse's principle. In each of the towers is an alarm, on which the signals are given from the police office, and a key or handle with which to return the signals. The alarm is so placed that it can be heard by the watchman (when "watchman" is mentioned in this description, it means, a *hugo*, those on the two towers) in his room, as well as when he is on his rounds. The handle is so arrangsd that the watchman can get at it without having to make a perfect round. In the Royal Town Administration Office is also an alarm, and a key or handle; the rest of the stations of the second circle, however, have only an alarm, so that they can only receive, but not give signals.

In order to be able to give notice in which part of the town a fire has broken out, the town is divided into three "rayons," or circles, the cathedral being the centre, which are called the inner circle, the outer circle, and the environs of the town. From the centre point of the octagon gallery of the tower, eight radii are formed, which divide each rayon into eight, whereby the town and its environs become divided into twenty-four districts. Each space between two radii has a special number, and a plan of the town divided in this manner is kept at each telegraph station. The telegraphing is carried out by means of pressing down the keys, and the signals are known by the number of strokes, and by the space of time between each stroke. The printing apparatus registers these by means of dots, strokes (—), and spaces. The signal on the alarm is either a simple short blow—so long as one can count 1, 2, 3, quick—or a sort of ringing done by striking the key continuously till one counts from 1 to 6. A space is the time between taking the finger off the key and again striking it. The space is a "short" one when 1, 2, 3, are counted, and a "long" one when one counts to 6 before again striking the key, both being counted quick. To enable the City Police Office to give a telegram to the second telegraph circle, two slides, numbered 1 and 2 on the apparatus, are put in. The printing apparatus can work slow or fast, as wished. The slow motion is used when controlling the watchmen, the quick motion when giving notice of a fire.

The signals for the announcement of a fire are as follows:—First, "The summons," whereby all the stations which it is intended to communicate with have their attention called that a telegram is coming. The summons of the watchmen to the City Police Office consists of 6 strokes and 5 short spaces. That from the cathedral is once rung, and that from the infirmary twice rung with a long space. The summons of the City Police Office on all the stations is three times rung with two long spaces. Secondly, "Understood," or "Ready." This is the answer from the station communicated with, that all is in readiness to receive the telegram. This signal consists of six strokes and five short spaces, both for the watchmen as well as for the police office. The answer "understood" has to be returned every time, when a telegram to announce a "fire," "danger," or "situation of the danger" of "fire" is given. When not given, the telegram is repeated till this answer is returned. Thirdly, "Danger." When the watchman observes an unusual quantity of smoke, such as to give him cause to apprehend a fire may break out, or notices in the environs of the town an unimportant fire in any of the gardens, he gives this signal with 12 strokes and 11 short spaces. Fourthly, "Fire." If, however, he observes actual flame, he then immediately gives the fire signal, which consists of 30 to 40 strokes given quickly one after the other. Fifthly, "Situation of the danger or fire." After the watchman has given notice of the "danger" or "fire," he waits until he can count 18, and then gives notice where the "danger" or "fire" is. The numbers 1 to 8 signify the spaces lying between each two radii, and are given notice of by 1, 2, 3, &c., with long spaces. These numbers, without any addition, denote the inner circle. Should, however, one of the outer circles have to be denoted, he must count 18 after the number has been given, and then give 2 strokes, with a long space, for the outer circle, and 3 strokes, with 2 long spaces, for the environs. If the watchmen give notice of "danger," the city police give notice of this to the second telegraph circle, that all may hold themselves in readiness in case of emergency, and the police immediately investigate whether ground for danger really exists or not. In the affirmative case, the watchmen get notice to give the "fire" alarm (see No. 4), which is immediately done. The city police give also the same alarm to the second circle. If, however, it is found unnecessary to give the "fire" signal, then the watchmen and the second circle receive the signal "no danger," which consists of 3 strokes and 2 short spaces. That the second circle may understand this more certainly, the city police repeat the signal after a longer space of time. The signals for controlling the watchmen are—Firstly, "The summons," which the police office, as before, telegraph to the two towers, with 3 strokes and 2 long spaces, which takes place at the time the night duty begins. The night duty is, in the months of December and January, from six o'clock in the evening till seven o'clock in the morning; from February till April, and September till October, eight o'clock to six o'clock; and from May till August, nine o'clock to five o'clock. Secondly, "Night duty begun" is the answer the watchmen give to this signal. The watchmen at the cathedral answer with a single stroke, that at the infirmary with 2 strokes and 1 long space. Each watchman has to repeat this signal every half hour—the one at the cathedral at the half and full hours, and the other at the infirmary at the quarters and three-quarters. By day-time, these signals are repeated only every hour, viz., from the cathedral at the full hours, and from the infirmary at the half hours. Thirdly, after the police officers have signalized the watchmen, they also signalize the second circle at the commencement of the night duty, with 3 strokes and 2 long spaces, to see that the whole apparatus is in proper working order, and are answered from the Royal Town Administration Office with "Telegraph in order" by a single stroke. This call, No. 3, is also heard at all the other stations of the second circle, but has for them no meaning, and they take no notice of it. Fourthly, the printing apparatus is principally to control the watchmen, and is so constructed that each time the watchmen press on the finger or handle in the towers, a short stroke (—) is indented on a strip of paper in the apparatus, which strip of paper can be made to travel quicker or slower through the instrument, or stopped altogether, as wished. For controlling, with slow motion, the paper travels at the rate of 4 in. in an hour; and so long as the watchmen give their signals regularly, the strokes follow each other at equal distances; should one of the watchmen, however, omit giving the signal, the strokes, in this instance, will be double as far apart as the rest; thus the watchmen are controlled without the presence of a third party.

At each station hangs a table with all the signals hitherto given, so that any of the parties interested can at any time see what signals to give or what they signify.

Should a fire break out at night, at which time the fire brigade are on duty at the police office, they immediately start off to the scene of the fire, with the fire escape wagon; should the signal "Danger" be given, they get themselves in readiness and wait for further instructions from the police, after the latter have investigated whether fire is present or not.

Thus, by the aid of this institution, it is now made possible, as soon as danger of fire is apprehended, to give notice of the same in the shortest

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possible time to the authorities and all parties interested, and at the same time to avoid all unnecessary alarm where no actual danger exists.

The following is a description of electro-magnetic telegraph in connection with the fire establishment in Berlin :—

The electro-magnetic telegraph (Morse's system) which was first laid down in 1851, embraces the whole of the 36 police districts of the city, most of the dwellings of the police lieutenants in which fire watch is kept, as well as the five outlaying fire stations; and, further, the dwellings of the state ministers and the General Post Office. This last connects it with the state telegraph, the head fire station, and, as the central point, the Royal Police Office.

The cost of this arrangement, which was carried out under contract by Messrs. Siemens and Halske, was rather under £5,000, and the yearly expenses of keeping it in order are about £750.

The staff of officers consist of an engineer, two chief, and two sub-telegraphists. The duties at the sub-stations are fulfilled by the firemen on duty.

In the middle of the city, at the Royal Police Office, is the central station, from whence five electrical circuits are carried, embracing the stations of the inspectors of the fire brigade; also, a circuit to connect the different ministerial dwellings and the general post, and one line direct to the head fire station. For the before-mentioned five outlaying stations, branch lines are taken from the nearest police station, which lines end in the watch room where an alarm apparatus is erected to give notice to the men on duty.

The wires are laid underground, 2½-feet deep, and are of copper covered with gutta percha in lead pipes, and cost about £120 a German mile (about 4¾ English miles). In the streets, where different wires meet, they are covered with earthenware covers, and in the neighbourhood of sewers or gas pipes they are laid in iron pipes to protect them from injury. Where the wires have to pass over the river Spree, they are laid under the pavement of the massive bridges, but where drawbridges occur they are laid under the bed of the river in flexible pipes.

The apparatuses are of Messrs. Siemens and Halske's (then) newest construction, with self-acting dial, and which, by thirty revolutions, communicates sixty to seventy words in the minute.

The batteries at the sub-stations consists each of twelve Daniell's cells; that at the chief station, of eighteen Daniell's cells, with porcelain cylinders, 5 in. in diameter, 1ft. high, and the copper and zinc elements in proportion, against which those at the sub-stations do not exceed the size of a beer glass. The whole of the apparatuses in the circuits are simultaneously fed by the battery in the central station. Attendance is constantly given at all the stations, and each dispatch is accurately entered in a journal. All dispatches, without any exception, must go through the central station, and through it alone are the connections of the stations with each other.

From the central station the dispatches can be given either to a particular station alone, or they can be communicated to the whole of the stations simultaneously, and are distinguished by the name of station dispatch, or circular despatch, accordingly. In the latter case (circular despatch) the circuit alone is used, which goes from the central station through all the stations, but, in the other case (station despatch), the circuit is made with the wire that goes to the particular station, the earth being the return. In this instance the connection to the further laying stations is, for the time, isolated, but these isolated stations can, in case of necessity, communicate any important despatch, in the meantime, to the central station by the remaining part of the circuit, using the earth as the return and they are enabled to set an alarm apparatus at the central station in action.

The completion of the circuits, the forwarding and communicating the despatches, as well as the isolating, is done by simple mechanical manipulation, for which special written instructions are given.

As an example of the mode of using the telegraph the following instance is given :—A fire breaks out, and notice is given at the nearest station, which is a police-station, and whether the same is given by a private person or one of the brigade, it is immediately telegraphed to the central station. The despatch is sent in the shortest possible form, for which rules are laid down; it contains the name of the street, number of the house, and size of the fire—this last simply by the letters—G (gross), M (mittel), or K (klein), which denote large, middle, or small, as according to this is known whether few or many of the brigade must be called out. From the central station notice is then first given direct to the head fire station, and then after, per circular, to all the sub-stations, and the whole is accomplished in about eight minutes.

The arrangements at the fire stations are such that in the course of three minutes everything is in readiness to start off, so that from the moment that the notice is given to the central station, in five minutes at the head station, and in eleven minutes at the sub-stations, everything is in readiness to start to the scene of the fire.

The batteries are cleaned daily by the fireman on duty; repairs required to be done have to be reported to the central station, and are ordered to be carried out by the competent officers.

The wires here referred to were the first in which copper covered with gutta-percha in lead pipes were used, and up to the present time, to judge from the little repair they require, give the best wished for results of their stability.—*Engineer.*

RECORD OF THE BRITISH ASSOCIATION.

MATHEMATICAL AND PHYSICAL SCIENCE, AND CHEMISTRY.

THE town of Cambridge has vied with the University in affording a welcome to the Association. The whole of the Guildhall has been placed at the disposal of the Association; the Council Chamber serving for committee meetings, while the general meetings are held in the new Hall.

The following gentlemen were elected as officers for the various sections :—

SECTION A.—Mathematical and Physical Science.—President, G. G. Stokes, M.A., Sec. R.S., Lucasian Professor of Mathematics, Cambridge. Secretaries: Professor Stevelley, LL.D.; Professor H. J. S. Smith, M.A., F.R.S.; Professor R. B. Clifton, M.A.

SECTION B.—Chemical Science.—President, W. H. Miller, M.A., For. Sec. R.S., Professor of Mineralogy, Cambridge. Secretaries: Dr. Odling, M.B., F.R.S.; H. W. Elphinstone, Esq., M.A.

SECTION C.—Geology.—President, J. B. Jukes, M.A., F.R.S., Director of the Geological Survey of Ireland. Secretaries: Professor T. R. Jones; Lucas Barrett, Esq., F.G.S.

SECTION D.—Zoology and Botany, including Physiology.—President, Professor Huxley, F.R.S., Sec. Geological Society. Secretaries: Dr. E. P. Wright, M.R.I.A.; Alfred Newton, Esq., M.A.

SECTION E.—Geography and Ethnology.—President, Francis Galton, Esq., F.R.S. Secretaries: Dr. Norton Shaw, Sec. R.G.S.; Thos. Wright, Esq., M.A., F.S.A.

SECTION F.—Economic Science and Statistics.—President, Edwin Chadwick, Esq., F.R.S. Secretaries: Edmund Macrery, Esq.; W. B. M'Leod, Esq.

SECTION G.—Mechanical Science.—President, Wm. Fairbairn, Esq., LL.D., F.R.S., &c. Secretaries: Peter Le Neve Foster, M.A., Sec. Society of Arts; W. M. Fawcett, Esq., M.A.

A sub-section, D, was appointed to be held in the hall of Trinity Hall. Dr. G. E. Paget was appointed President; and Dr. E. Smith, F.R.S., and G. F. Helm, Esq., Secretaries.

The following gentlemen were appointed Vice-Presidents :—

SECTION A.—Rev. Dr. Whewell, F.R.S.; Rev. Dr. Robinson, F.R.S.; Rev. Prof. Challis, F.R.S.; Rev. Dr. Lloyd, F.R.S.; Rev. Prof. Price, F.R.S.; Prof. Adams, F.R.S.,; General Sabine, F.R.S.

SECTION B.—Dr. Gladstone; J. P. Gassiot, Esq.; Rev. W. V. Harcourt; Dr. Daubeny; Dr. Jordan.

SECTION C.—Rev. Prof. Sedgwick; Sir C. Bunbury; Prof. Ansted; Sir C. Lyell.

SECTION D.—Rev. Dr. Cookson, Master of St. Peter's College; Edwin Lankester, Esq., M.D., F.R.S.; Prof. Balfour; J. G. Jeffreys, Esq.; Rev. L. Jenyns.

SUB-SECTION D.—Professor Owen; Dr. Humphrey; Dr. Robertson; Dr. Davy.

SECTION E.—J. Craufurd, Esq., F.R.S.; William Spottiswoode, Esq., M.A., F.R.S., Treasurer of the British Association; Rev. J. W. Blakesley, M.A.; Rev. George Williams, B.D.

SECTION F.—Colonel Sykes; William Tite, Esq., F.R.S., M.P.; Thos. Webster, Esq.; James Heywood, Esq.

SECTION G.—Dr. Robinson, F.R.S.; Prof. James Thomson; James Nasmyth, Esq.; Charles Vignoles, Esq.

The undermentioned were appointed as members of the Committee of Recommendations :—Professor Price; Dr. Lloyd; Rev. N. M. Ferrers; Professor Miller; J. P. Gassiot, Esq.; Rev. W. V. Harcourt; J. B. Jukes, Esq., Director of the Geological Survey of Ireland; Professor Sedgwick; Sir C. Lyell; Professor Huxley; Professor Babington; Dr. Daubeny; Dr. Paget; Professor Owen; Dr. Davy; Rev. W. Campion; Francis Galton, Esq.; J. Craufurd, Esq.; E. Chadwick, Esq., C.B.; Colonel Sykes; Thos. Webster, Esq.; Dr. Robinson; and William Fairbairn, Esq.

On the 2nd inst., Mr. F. Fairbairn, the President of the past year, introduced Professor Willis as his successor in this office, referring, at the same time, to the eminent services Mr. Willis has rendered to science.

In Section A, Mr. C. Tomlinson made a communication "On the Sublimation and Condensation of Camphor and other Bodies in the Direction of the Light." Referring to the experiments of Chaptal and Dr. Draper, he doubted the correctness of the conclusions at which they arrived, and attributed the phenomena solely to the action of heat.

Mr. Isaac Ashe communicated some "Suggestions on Balloon Navigation."

Mr. James Nasmyth made a communication "On some Peculiar Features in the Structure of the Surface of the Sun."

Professor Challis next read a paper "On the Extent of the Earth's Atmosphere." He argued that, at all events, there was a limit to the height of the atmosphere in one respect, viz., it did not extend to the moon. Astronomers held, that the rotation of the earth upon its axis was the most constant thing in nature; and if that were so, we had *primâ facie* evidence that the earth's atmosphere did not extend to the moon. Professor Challis next read a paper "On the Augmentation of the Apparent Diameter of a Body by its Atmospheric Refraction."

In the evening, at the Guildhall, Professor Tyndall delivered an

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interesting lecture, illustrated by numerous experiments, "On Water, in its Various Conditions, Gaseous, Liquid, and Solid."

On the 3rd instant (in Section A), Mr. Plant read a paper "On Meteorology," in which, after referring to the wind-guage of Dr. Croune, and the more recent systems of Wolfius and Martin, he gave a detailed account of the working of Osler's anemometer of which he said:—"We are much indebted to Mr. Osler for his useful anemometer. Should a storm occur at ever so remote an hour of the night, the recording apparatus of this instrument will proceed with its registers. If a 20lb. pressure takes place at two, three, or four o'clock in the morning the register will be found, and the speed and direction of the wind will also be traced. Every deposition of rain is most exactly set down on the scale, and so minutely that, whatever quantity falls at intervals, no matter how irregularly, all will be duly registered, and, together with the direction of the wind, will be found traced on the paper."

The Rev. R. Main presented two memoirs on astronomical subjects.

Professor Selwyn made a communication on "Autographs of the Sun obtained by means of the Heliautograph."

Mr. Fleeming Jenkin then presented a provisional report "On a Proposed Standard of Electrical Resistance," and also a paper "On Themoelectric Currents in Circuits of one Metal."*

The remaining papers were as follows:—

Mr. Arthur Cayley, "Report on certain Dynamical Problems," "On a certain Curve of the Fourth Order," and "On the Representation of a Curve in Space, by means of a Cone and Monoid Surface;" Mr. W. H. L. Russell, "Some Account of Recent Discoveries made in the Calculus of Symbols;" Rev. R. Harley, "On a certain class of Linnear Differential Equations;" Rev. Dr. Booth, "On an Instrument for Describing Geometrical Curves," invented by Henry Johnson; Mr. G. R. Birt, "On Three New Craters in the Moon," not in Beer and Madler's Map (read by Dr. Lee); Rev. Professor Challis, "On the Zodical Light and Shooting Stars."

On the 4th instant, Mr. Isaac Ashe, M.B., read before the Mathematical and Physical Section a paper suggesting the use of compressed gas applied on a new principle to the elevation of a column of liquid for barometric purposes.

The Rev. Dr. Lloyd presented the Report of a Committee to inquire into the adequacy of existing data for carrying into effect the suggestion of Gauss relative to the application of his general theory of magnetism to magnetic variations.

Mr. F. J. Evans presented a report "On the Three Reports of the Liverpool Compass Committee."

Professor Stokes read a report "On Double Refraction."

Mr. A. Des Cloiçeaux read a memoir in French "On the Relation of the Phenomena of Rotary Polarisation and certain forms of Crystals with one or two Oblique Axes."

Dr. E. Esselbach read a paper, "On an Experimental Determination of the absolute quantity of Electric Charge."

Mr. J. Ball made a communication "On the Determination of Heights by means of the Barometer."

The remaining papers were by Mr. Hirst "On the Volume of Pedal Surfaces," and Mr. W. Ogilby, F.G.S., "On the Eccentricity of the Earth, and the Method of finding the co-ordinates of its Centre of Gravity."

The papers read before the Chemical Section were as follows:—

"On a Photolithographic Process adopted by the Government of Victoria for the Publication of Maps;" Mr. G. C. Foster, F.C.S., "On the Principles upon which Atomic Weights should be Determined;" Mr. W. Olding, M.B., "On the Nomenclature of Organic Compounds;" Dr. G. Harley, "On Schonbein's Antozone;" Dr. B. H. Paul, "On the Manufacture of Hydro-carbon Oils, Paraffin, &c., from Peat;" Mr. D. Campbell, F.C.S., "On the Action of Nitric Acid upon Pyrophosphate of Magnesia."

In the evening, Dr. Odling delivered a lecture "On Organic Chemistry," which was illustrated by a variety of interesting and, in many instances, very beautiful experiments.

On the 7th inst. (Section A), Col. Sykes read "The Report of the Proceedings of the Balloon Committee."

Mr. Glaisher then read his paper "On his recent Balloon Ascents, with Mr. Coxwell," the most popular, and one of the most interesting communications made to the Section.

Dr. Esselbach read papers "On the Duration of Fluorescence," and "On Electric Cables, with Reference to Observations on the Malta Alexandria Telegraph."

Papers were read by Mr. W. Esson, "On the Curvature of the Margin of Leaves, with Reference to their Growth;" by Professor J. Thomson, "On Disintegration of Stones exposed, in buildings and otherwise, to atmospheric influences."

A report, by Mr. J. Ball, "On Thermometric Observations in the Alps," was next read.

Dr. Lee read a paper "On a Brilliant Elliptic Ring in the Planetary nebulæ, R. A., 20h. 56m., N.P.D., 101° 56′," communicated by Mr. Lassall.

Papers were read by Mr. Isaac Ashe "On some Cosmogonical Speculations by Mr. G. Miller Guy;" an account of an electromotive engine; and by Mr. C. N. Willich, "On some Models of Sections of the Cube."

* We propose, at the first opportunity, to refer *in extenso* to these and other communications more immediately bearing on electrical science.

On the 6th inst., Mr. Glaisher presented a Report "On Luminous Meteors."

Papers were read by—

Professor Sylvester, "On the general solution of the Linear Equation in Finite Differences."

Professor G. Boole, "On the Differential Equations of Dynamics."

Mr. R. Mallet, "On the Measurement of the Temperature of Active Volcanic Force to Considerable Depths, and of the Temperature and Issuing Velocity of the Steam and Vapour evolved."

Professor Hennessy presented a communication, "On the Relative Amount of Sunshine falling on the Torrid Zone of the Earth."

Dr. Gladstone made a communication, "On the Distribution of Fog round the Coast of the British Isles."

The following papers were also read:—Professor Rankine, "On the Form and Motion of Waves at and near the Surface of Deep water;" Mr. J. Park Harrison, "On the Additional Evidence of the Indirect Influence of the Moon over the Temperature of the Air, resulting from the Tabulation of Observations taken at Greenwich in 1861-2;" Mr. E. J. Lowe, "On the Hurricane, near Newark, of May 7, 1862, showing the Force of the Hailstones and the Violence of the Gale;" Mr. F. Galton, "European Weather Charts for December, 1861," and "Description of the 'Boussole Burnier,' a new French Pocket Instrument for Measuring Vertical and Horizontal Angles;" Mr. S. A. Rowell, "On Objections to the Cyclone Theory of Storms;" Rev. Thomas Rankine, "Meteorological Observations" (read by one of the secretaries); Mr. A. Claudet, "On the Means of following the Small Divisions of the Scale regulating the Distances and Enlargement in the Solar Camera.

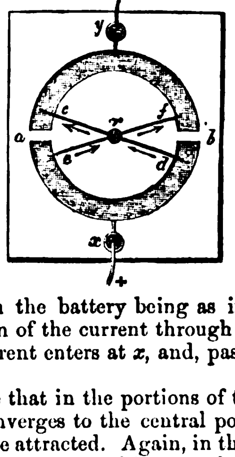
The Student.

ELECTRO-DYNAMIC PHENOMENA.

Action of a Current upon a Current.—One of the propositions relating to the action of currents upon each other, contained (p. 235) in our last article under this heading, may be experimentally verified by the construction of a very simple apparatus, which we will proceed to describe. The proposition in question is:—that in two conductors crossing each other, but not in electrical contact, those portions in which the current either converges or diverges from the point of crossing will be attracted, while the portions, in one of which the current approaches, and in the other of which the current recedes from this point will be repelled.

The following figure represents a block of wood or other material, in which are cut two semicircular grooves, to contain mercury or other fluid conductor, separated by the non-conducting divisions *a* and *b*. On a pivot at *r* is poised in the first place a metallic needle, *c d*, the extremities of which, brought to a point, are bent at right angles, so as to dip into the mercury contained in the grooves. To this needle, immediately above the point of suspension, may be attached a minute fragment of gutta percha, or other non-conductor, carrying a point which may serve as a pivot on which to suspend a second similar needle, *e f*. When the wires attached to the poles of a battery, which should be of considerable power, are brought into connection with the fluid conductor at *x* and *y*, we have obviously in this arrangement two metallic conductors, each of which transmits the voltaic current from one of the grooves to the other, which cross at a certain angle, and which are not in electrical contact.

Fig. 1.



The connection with the battery being as indicated by the signs + and —, the direction of the current through the wires is indicated by the arrows; the current enters at *x*, and, passing through the two needles, escapes at *y*.

Now we may observe that in the portions of the conductors marked *c* and *d*, the current converges to the central point *r*. These two portions should therefore be attracted. Again, in the two portions marked *e* and *f* the current diverges from this central point; and attraction

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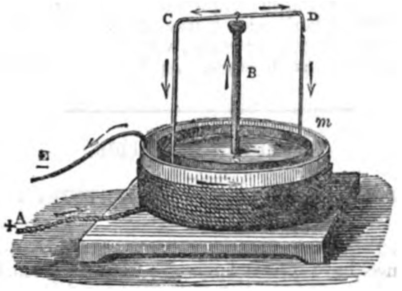
should also take place between c and f. In the two portions marked f and d, on the other hand, the current is proceeding in opposite directions, to and from the point of suspension, and repulsion should consequently ensue. The same condition prevails in the two portions of the conductors marked c and e. The forces of attraction and repulsion combine to bring the needles together in the direction from x to y; and if the current be sufficiently powerful, and the needles carefully suspended and adjusted, this effect will be found to take place.

Rotation of a Current by the Action of a Current.—If we imagine a moveable vertical conductor to be conveying an electric current in a direction at right angles to a horizontal current, without crossing the latter, it may easily be deduced from the above that at the point where the vertical conductor would, if continued, intersect the horizontal current, attraction and repulsion must take place. The movable conductor would be attracted by that portion of the horizontal conductor in which the direction of the current, to or from this point, was the same as in the moveable conductor, and it would be repelled by that portion in which the current moved in the opposite direction. On this principle depends the action of the following apparatus.

Fig. 2.



This consists of a vessel, in the centre of which is fixed a rod of metal, B, surmounted by a metallic capsule to contain mercury. In this is plunged an iron point, supporting a copper wire, D C, bent twice at right angles, so that its extremities may dip into the fluid to be contained in the vessel. The extremities of the wire may be attached to a copper ring, as shown in the figure. A covered wire, having one of its ends in electrical communication with the metallic rod B, is coiled round the vessel—a considerable number of turns being necessary, as in the galvanometer, to increase the effect due to a single turn of wire. The other extremity of this wire is shown at A. The vessel being nearly filled with dilute sulphuric acid, or other fluid conductor; one of the poles of a voltaic battery is connected to A, and a wire E attached to the other pole is plunged into the fluid. Or, if the cylindrical portion of the vessel be formed of copper, which is preferable, one of the poles of the battery may be connected to this metallic part of the vessel.

These arrangements being completed, the wire C D will immediately rotate in a direction contrary to that of the current traversing the coiled wire A.

Supposing the positive pole of the battery to be connected to the extremity of the wire A, and the wire E to be connected to the negative pole, the current will enter at A, and, after making a number of circuits round the vessel, will pass up the pillar B, from the cup of which it will proceed in both directions through the suspended copper wire, thus reaching the fluid, and passing through E to the negative terminal of the battery.

We thus realize the condition of a moveable vertical conductor conveying a current in a direction at right angles to a horizontal current. By referring to the figure, it will be seen that the portion of wire C conveys a current *towards* a point in proximity to the coiled conductor. The latter also conveys a current *towards* this point, and, after passing it, conveys the current *from* this point. The wire C will be attracted by the portions of the coiled conductor which convey the current towards, and repelled by those portions which convey the current from the point in question. And, consequently, the moveable system will rotate in a direction *contrary* to that of the current through the fixed conductor.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

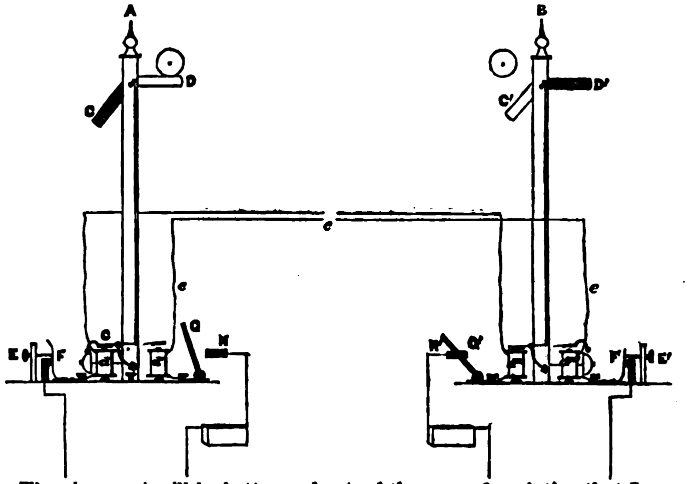
RAILWAY TELEGRAPHS.

To the Editor of The Electrician.

Sir,—After the valuable and instructive paper that has appeared in The Electrician it is almost superfluous for me to say anything; but the subject being of such great importance, and one to which I have devoted many of my spare hours during the last two years, I trust I shall be pardoned should the instrument I wish to suggest be thought impracticable. I have had the instrument planned a long time, but have never had the opportunity to show it to any practical railway man; in fact, I have been afraid of receiving discouragement, for there are few who would give that attention to the subject which it requires.

Since learning that Mr. Preece has found almost similar, but more complicated and intricate instruments to work so well, I have less fear of the scrutiny the plan will have to undergo, and for which I care not if I can add anything towards the solution of so important a problem as the prevention of those fearful accidents that have startled the public and railway proprietors from time to time.

No doubt many readers of The Electrician will see faults in the system that I cannot, and I shall be glad if they will kindly point them out.



The above cut will be better understood than any description that I can give.

A is an instrument supposed to be at one end of a tunnel, and B a similar instrument at the opposite end. It will much simplify the following description if we call the line from A to B the "*down line*," and from B to A the "*up line*." C is the arm of the miniature semaphore to regulate the traffic on the "*down line*," and D the one for the "*up line*." c is the armature of the electro-magnet d, which may be similar to those used for the bell telegraphs, fully described in The Electrician, page 284; I is a small weight to adjust the instrument either for a weak or a strong current of electricity; *e e e* are the line wires; G is the switch, which, when moved to H, will cause a current of electricity to flow through the electro-magnet d' along the line wire *e e e*, through the electro-magnet d''' to earth, attracting the amatures and, consequently, lowering the semaphore arms D and D′. As the signals are placed in the cut the "*down line*" is "*clear*," and the "*up line*" "*blocked*," or "*train on line*." If a train be approaching the down line the signalman at A will press the knob E, which will disconnect the spring F, and cause the arm C and C′ to rise and strike the bell at B, this may be repeated two, three, or four times, and will be the signal for the man at B to block the line, by moving the switch H′ to G′, the semaphores will then stand at "*line blocked*." A will now have no further power to alter the "*down line*" signals, and will allow no train to pass him until the the arm is again lowered by the man at B, which he will do by putting *current on* when the train has passed. No acknowledgment is given, nor is any required, for the down line signals cannot possibly be moved to "*line clear*," except by the man at B, and the up line signals by the man at A. The semaphore arms C and D′ will be painted red, and D and C′ white, so as to correspond with the outdoor signals now in general use on the leading railways.

This instrument would, I think, go far to meet the requirements of Mr. E. Clark, referred to by Mr. Preece in the paper on "Railway Telegraphs," page 195.

"1st.—The machinery is of the most simple and evident description, not liable to disarrangement, and easily repaired.

"2nd.—The signals are simple and few, and so distinct that no mistake can occur.

"3rd.—No dependence is placed on the memory of the person in charge, and the signals are permanent, and not temporary, or liable to misconstruction."

And, lastly, no accident can be actually caused by the derangement of the apparatus, or absence of the signalman, but such absence or derangement will merely cause the delay of the train.—I am, sir, yours sincerely,

Inquisitive.

[It is obvious that the general principle of the above, viz.: the working of a miniature semaphore by an electro-magnet, is the same as that which has been applied by Mr. Preece. We leave the respective merits of the details of construction to be discussed by those of our readers who are interested in this question.—Ed. E.]

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To the Editor of The Electrician.

Sir,—In the course of conversation with some friends of mine, in Essex, upon the subject of electric telegraph communication, I have been compelled to listen to numerous anecdotes of official delinquencies on the newly called Great Eastern line of railway, but I must confess, not any of them materially more scandalous than what I have heard of other lines. However, for the sake of keeping the public attention to the subject, whilst they remain alive to the mercantile and social value of the electric telegraph as a means of rapid and reliable correspondence, I beg for a short space in your journal, that I may ask the reason why so much time is wasted in the preparatory arrangements, which the officials think necessary before they will condescend to place your message before the operator at the instrument.

The customary routine, if you send your servant to the station, even if he happens to be a person of most diligent habits, and does not lose a moment on his way thither, is this: your servant arrives at the office, and, after exchanging the customary civilities of his class, which consist of good tempered badinage, accompanied by common-place platitudes respecting the weather and the crops, interspersed with social interchanges and enquiries about the health and welfare of the relatives and friends of the respective railway porters, grooms, and idlers, who usually hang about the portals of a station, and are commonly connected by family relation or fellow service with your own domestics; perhaps, if he be very diligent, and fully alive to the fact that his business consists of delivering a letter to the telegraph clerk in the shortest possible period of time, from the moment that he receives it from his master's hand, perhaps he finds himself before a blank partition, about seven feet in height, with a small pigeon hole, most likely closed, without the slightest chance of its being opened again until ten minutes before the next train arrives, a short time before which, he may, with some probability, expect to see a youth enter, attired in the conventional respectability of blue broad-cloth (three suits a year, and the old ones taken in exchange by an eminent advertising firm in London), who, if he be so attired, with the addition of a caneframed blue cap, set somewhat jauntingly on his head, may be taken to represent the telegraph clerk, who has, until lately, been distinguished by his general good behaviour at the village school, and the consequent patronage by the squire or the clergyman of his native place, and the good opinion of his own family and supporters, if the flattery and encouragement he has received out of doors has not rendered him unbearable at home. This highly respectable-looking individual, after having entered with a flourish, and adjusted certain stools and books with sundry slams and jars of the partition, slides open the pigeon-hole, evidently prepared for action, the first scene of which generally presents a pantomimic aspect. The young gentleman opens the despatch, and with an air of easy nonchalance, after unfolding it, holds it at arm's length in one hand, whilst he slaps it with the back of the other, and without condescending to give utterance to his thoughts, he places the outspread paper on the desk-slope before him, and sprawling on his elbow over it, he at length begins to count the words, and slowly and oracularly pronounces the price; this stage of the proceedings brings them to about twenty minutes from the time of the clerk's arrival, he then begins to manipulate the machine, which, in some cases, resembles the sound produced by a post office keeper stamping letters, only the concussions are with greater velocity and noise interspersed with frantic ringings of a little bell; after a short and sharp electric engagement, a truce appears to have been made between the operators at each end of the line, and our friend assumes the position of stand at ease, with the exception that he still retains the handles of the machine in both hands, whilst he fixedly regards the dial before him, after having made up his mind that they are communicating with some other station, he comes again to the desk, and goes through the usual formalities with pens, ink, and paper, and your servant leaves with the vague impression that your message will be delivered some time in the course of the day, but with the very firm conviction that his master must have a great deal more money than wit.

If, however, you are more anxious upon the subject, and determine to see that the message is sent, and to receive a telegraphic acknowledgment yourself, you hasten off to the office, *in propriâ personâ*, you find the pantomime slightly diversified, by having to be instructed as to the most condensed methods for expressing your thoughts; and after having submitted your performance to the amendment of the clerk, your feelings are slightly irritated by a kind of vague consciousness that you are being made the subject of a telegraphic raillery between the two operators, and that any ebulition of temper on your part, will be followed by a fresh sally of pleasantry between the young gentlemen, and a further delay, until you are glad to slink out of the office, with an unpleasant feeling of having parted with valuable coin in exchange for more than an hour's irritation of temper, about a proceeding, which you are fully convinced will be utterly futile in its effect, through the delay, which you never dreamed of having to endure, when the thought first prompted you to employ the telegraph.

Repeated disappointments and delays will severely discourage the public in its support of the telegraph system, and consequently deprive it of a source of income which could be well invested in increased facilities and improvements for the public convenience.

I have this day received a letter from an intimate friend at one of the principal towns in Essex, in which he complains that, having occasion to send a telegraphic message to Bury, in Suffolk, he was compelled to wait more than one hour before they would take it in London, because he was assured that, although telegraphing from the principal town on the Colchester line, about midway between Bury and London, no message could be sent except *viâ* London, and, in consequence of the delay, his message was of no avail. Again, last Sunday he telegraphed to Putney, in Surrey, and "he had to wait nearly half an hour, whilst the clerk was finding out how it was to go." He says, also, that there is a deficiency of electric telegraph accommodation in the Eastern counties. I am not much surprised at that, because being, to a great extent, an agricultural county, there are few densely populated and commercial centres to give active vitality to the system, and private individuals have little encouragement to employ it as an expensive luxury, if they cannot depend upon its unfailing expedition.—I am, sir, yours obediently, Philanthropos.

London, October 2, 1862.

To the Editor of The Electrician.

Sir,—Could you or any of your correspondents answer the following questions:—1. I am very desirous of becoming acquainted with the theory of thermo-electricity; could you recommend a book treating on that subject? I was greatly surprised in seeing so little mention of it in The Electrician. I am of opinion that if the subject was taken into consideration something might be made out of it. 2. I wish to get some good porous jars; could you recommend some, for I have had two or three which after only being in action a short time fell in pieces? 3. On what principle is Mr. Allan's relay worked? 4. If a rope from a flag-staff was in contact with telegraphic wires, would it hinder the transmission of signals? I have seen such cases. Apologizing for troubling you.—Yours, &c., C. A.

Telegraphic News.

TELEGRAPHIC COMMUNICATION BETWEEN FRANCE AND SPAIN.

The Submarine Telegraph Company between Great Britain and the continent of Europe, have received advices from the French Government that the telegraphic communication with Spain and Portugal, which had been interrupted since the 17th inst., has been re-established.

The Pacific Telegraph Company have errected their wires between the Missouri and the Sierra Nevada, a distance of 1600 miles, and thus completed the telegraphic communication between the Atlantic and Pacific in four months and seventeen days. The company have entered into an arrangement with the Emperor of Russia, by which, conjointly, they will construct a continuous line through British and Russian America, across Behring Straits, and through Asiatic and European Russia, so as to connect St. Petersburgh and Washington. This line will be 14,000 miles in length. Russia has already completed 3500 miles, and collected materials for extending the wires, from Siberia to the mouth of the Amoor, the Mississippi of Asiatic Russia.

On Saturday evening last, the chief clerks and others belonging to the Magnetic Telegraph Company's staff at Manchester, assembled to the number of thirty, at the George Street Institution in that town, to inaugurate a mutual improvement society. Mr. Robert Dodwell presided, and announced that a suitable room for the members would be provided at the company's offices, in Ducie Place, together with a library, containing about forty volumes, relating to electrical knowledge, and the leading scientific periodicals. All who were present gave their adhesion to the new society, and the proceedings, which included an elaborate and well written paper by Mr. Parker, on the value of such associations, were such as to give great promise for its future welfare.

Upon leaving the chair, Mr. Dodwell was greeted with the most enthusiastic cheers, in acknowledging which he stated that, during the time he had been their superintendent, he had gained the character of being too strict in discipline, but such a reception as he had met with from the chief members of his staff, encouraged him to go on as he had done, and with their help, to make the District the most efficient in the service.

An excellent dessert was then provided, and the evening devoted to songs and recitations by the members present, many of the selections being well rendered, especially by Mr. Lucas and Mr. Barker.

To Correspondents.

J. Cook.—You will find the tension in your proposed arrangement precisely the same as when the elements are otherwise disposed; but the resistance will be greatly augmented if, as we apprehend, the *external* surface of the cast iron cylinder with porous bottom is not intended to act as a negative, and consequently is to be protected by a non-conducting material. In this case you will perceive that the current from zinc to iron, through the fluid, will have to encounter comparatively a great resistance, attended with an equivalent reduction in the quantity of electricity set in motion. If the outer surface of the cylinder be not protected, then the inner surface and the nitric acid might well be dispensed with.

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The Electrician.

Vol. II. No. 50.—October 17, 1862.

CONTENTS:

	Page		Page
The Chemical Theory of the Voltaic Couple	277	Recent Patents	283
Some Considerations on the Principles of Electrical Conduction and Accumulation	278	An Account of Researches in Electro-Chemistry	284
The Galvanic Circuit Investigated Mathematically	279	Prices Current of Insulating Materials	287
Note on the Theory of Spherical Condensers	280	Telegraph Shares	287
Catalogue of Books and Pamphlets on Electricity, &c.	281	Effects of Voltaic Electricity in Restoring Animal Life	287
Record of the British Association	282	Correspondence	287
		Telegraphic News	288
		Miscellanea	288
		To Correspondents	288

THE CHEMICAL THEORY OF THE VOLTAIC COUPLE.

[Continued from page 266.]

If we immerse a plate of zinc in water contained in a vessel of copper, and, by abstraction of the sensible and latent heat of the fluid, cause the latter to assume a solid form as ice; we constitute, under certain conditions, a self-charging Leyden arrangement, in which the solidified water constitutes the dielectric. By connecting, through a delicate galvanometer, the zinc and copper elements, corresponding to the inner and outer coatings of a Leyden jar, we may "discharge" the arrangement, with the production of a temporary current indicated by the galvanometer. After a very short period, if the temperature of the contents of the cell be not *under* 32 Far. we shall find the Leyden arrangement again charged, though, of course, with electricity of very low tension, necessitating the use of the condenser to render its presence evident in a static form.* If the temperature be under 32°, we may immediately produce the difference of tensions in the metallic elements, by touching the zinc with an insulated heated body. From this and other facts, we may perceive that polarization, resulting necessarily in electrical induction, is the first stage in the phenomenon of conduction. With a plate of ice, instead of glass, we may form the Leyden "coated pane," by applying to the surfaces two sheets of metal, connected to the opposite poles of the battery, or to the rubber and prime conductor of the electrical machine. Or, if one of the sheets of metal be connected to either pole of the battery, and the other to earth, the latter will become charged by induction. The first stage of conduction takes place in the polarization of the molecules of the solidified fluid; the second stage, that of the transfer of atoms from molecule to molecule, does not, in this case, take place, or occurs to a very minute extent, by reason of the resistance to such conductive action, produced by the peculiar conditions of crystalline aggregation in the molecules. In the case of our self-charging Leyden jar, there is no actual transfer of electricity from one molecule to another, accompanying the transfer of atoms; the zinc acquires a negative tension by combination with oxygen, from a minute portion of fluid in contact with its surface, and the copper acquires its positive tension by induction through the dielectric of ice. That this is the case is shown by the facts that the difference of tensions is proportionate, as in all cases of statical induction, to the thickness of intervening dielectric: and that this difference of tension remains constant for whatever length of time the experiment may be continued, which would not be the case if hydrogen were disengaged from the surface of the copper. We have, however, sufficient grounds for the assumption that, whether the water be polarized as a dielectric or as an electrolyte, the oxygen atom of each molecule is disposed towards the positive and the hydrogen atom towards the negative metal.

Admitting the polarization of the fluid to take place in the manner described, and to be due, at least in part, simply to the electro-attraction of the positive metal for oxygen, we still have to take into consideration several circumstances, in order clearly to account for the fact that the hydrogen is liberated at the surface of the negative metal, and that, in fact, a decomposition of molecules takes place, resulting in electrolytic conduction. For we perceive that in the absence of the negative element, or while the voltaic circuit is incomplete, the hydrogen of the water, decomposed by the oxidation of the positive element, is evolved from the surface of the element, while the fluid becomes charged positively. If the action were precisely the same when the circuit was complete, the dynamic effect would necessarily be extremely feeble, owing to the fluid being possessed of little or no conducting power in the absence of electrolytic action. We may readily, however, realize the conditions which result in electrolytic transfer and conduction. In the normal condition of an electrolyte, the molecules are individually held together with a greater or less degree of force, by the attraction of their constituents. In the polarised electrolyte, the molecular force is diminished by the mutual attraction for each other of the positive and negative constituents of each molecule, which are held in juxtaposition. It appears, therefore, that, in regard to the atom of hydrogen liberated from a molecule of water, in the oxidation of the positive element, a comparatively small external force will determine its combination with the oxygen of the molecule of water in proximity to it in the line of polarisation. This force is to be found in the electro-attraction for *hydrogen* of the negative element of the couple, which tends to set free the *oxygen* of each molecule in the line of polarisation. Thus is determined the liberation of hydrogen at the surface of the negative plate, rather than at any other point in the line of polarised particles. We have, therefore, reason to assume that the negative element, in proportion to its electro-negative nature, exerts an influence in the polarisation of the electrolyte; an assumption which is borne out by the fact that the difference of tensions in the couple, which is dependent upon the *degree* in which this polarisation takes place, is found, *ceteris paribus*, to vary according to the electro-negative affinities of the materials of which the conducting plate is formed.

We have adverted to the fact that a portion of the hydrogen liberated at the surface of the negative element is not actually evolved, but apparently remains adherent to it, interfering very materially with the external voltaic effect. This phenomenon, which is of considerable interest in an abstract point of view, is also specially worthy of attention in its practical bearings, and appears to have been inadequately studied. Previously to entering upon the consideration of its character and probable nature, and discussing the various means by which its effects may be obviated or diminished, we have to revert to the question which has been raised, relative to the effect of this film of oxidisable hydrogen, in reducing the difference of tensions in the voltaic elements. In a physical point of view, this effect might not appear susceptible of being readily or clearly explained, and, in in the absence of a careful experimental verification, its existence might, as we have seen, be a disputed point. From our present point of view, however, we cannot but perceive that the presence of a film of electro-positive matter upon the surface of the negative element, must necessarily destroy the influence of the latter in effecting the polarisation of the electrolyte. The metal, electro-negative to hydrogen, and, therefore, when in perfect contact with the electrolyte, assisting in the polarisation of the molecules of the fluid, retains a portion of the hydrogen liberated upon its surface, and, under this condition, ceases to exert its electro-attraction for the hydrogen of the fluid molecules. In the absence of a knowledge of the nature of the condensed hydrogen, we cannot explain why a *portion* only of that which is liberated at the negative element is thus retained, and under what circumstances the remainder becomes evolved into the atmosphere.

(To be continued.)

* The experiment may be performed by connecting the zinc plate to the terminal wire of a battery of ten or more couples, of which the copper terminal is led to earth. The electricity induced in the copper vessel when uninsulated, may then be readily evidenced by the electrometer.

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SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 268.]

THE following will show how perfectly the deductions from Green's theory agree with those I have just given, and when we consider, that the mode I have adopted of considering the subject is simply an application of laws originally given by Ohm, as those for conduction only, whilst Green* appears to have directed his attention entirely to problems of electro-statics, the coincidence of the results in the two cases is somewhat remarkable.

First, then, with regard to the quantity on the spheres being directly as their radii, we have, on page 32 of "Green's Essay," the following equation for the quantities on two spheres in equilibrium, and joined by a fine wire—

$$Q\left(\frac{1}{a}-\frac{1}{b}\right)=Q'\left(\frac{1}{a'}-\frac{1}{b}\right) \qquad (1)$$

where Q and Q′ are the quantities on the two spheres, a and a' their radii; and b the distance between their centres. "Thus," Green writes, "the ratio of Q to Q′ is given by a very simple equation, whatever may be the form of the connecting wire, provided it be a very fine wire."

Now, it is evident, if b is infinite, $\frac{1}{b}=0$, and the equation becomes—

$$\frac{Q}{a}=\frac{Q'}{a'},$$

or $Q : Q' :: a : a'$, *or the quantity in the spheres is directly as their radii*, and, therefore, if b is simply very great, the same will practically result.

And, again, with regard to the densities, we have immediately after the preceding quotation the following paragraph and equation:—

"If we wish to put this result of calculation to the test of experiment, it would be more simple to write P and P′ for the mean densities of the fluid on the spheres, or those which would be observed when, after being connected as above, they were separated to such a distance, as not to influence each other sensibly. Then, since

$$Q=4\pi a^2P \text{ and } Q'=4\pi a'^2P'.,$$

we have by substitution, &c.,

$$\frac{P'}{P}=\frac{a\,(b-a)}{a'(b-a')}. \qquad (2)\dagger$$

We, therefore, see that when the distance b, between the centres of the spheres, is very great, *the mean densities will be inversely as the radii.*"

Thus, in these two cases, the results, proceeding from the two modes of dealing with the problem, are identical,‡ and from them we deduce these very simple laws, with regard to spheres.

1. If two spheres are widely separated from all surrounding objects, and from one another, and connected by a fine connecting wire, then, if a charge be communicated to them, the *quantities* on the spheres will be to one another *directly as their radii.*

2. And, under the same circumstances, the *densities* will be *inversely as the radii.*

3. The *quantity* on a sphere widely separated from all surrounding objects connected to one pole of a given source, having its other pole connected to surrounding objects, will be *directly as its radius*, and the *density will be inversely as its radius.*

4. If a given quantity be imparted to a sphere widely separated from surrounding objects, the *tension* to surrounding objects will be *inversely as its radius.*

These results are contrary to those which have been occasionally promulgated, for we find it is sometimes stated that the quantity on two spheres connected by a chain or wire, will be proportional to their surfaces. (See De La Rive, vol. i. p. 8; and Lardner and Walker, vol. i. pp. 248, 249.)

This would only be true, however, when each sphere is surrounded by a shell having a diameter greater than that of the sphere which it surrounds, by a quantity that shall be the same for both spheres and shells, and which quantity shall only be a very small fraction of the diameter of the lesser sphere. In which case the shells of dielectric, being in both cases very thin in comparison to their radii, may be considered as prismatic resistances, of which the lengths are represented by the thickness of the shells of dielectric, and the sectional area by the surfaces of the spheres; or, in fact, they may be considered as flat plates of dielectric of the same thickness for both spheres, but having surfaces equal to the surfaces of the spheres respectively. Since, therefore, in the equation—

$$R=\frac{L}{S},$$

L is constant, and S is directly as the squares of the radii of the spheres, the *inductive resistance* in such case will be, therefore, *inversely* as the squares of the radii; or, in fact, inversely as the surfaces of the spheres; and, consequently, the *quantity* will be *directly* as the squares of the radii, or *directly* as the *surfaces of the spheres.*

This is in perfect harmony with the formula—

$$R=\frac{r'-r}{r'\,r}.$$

For if spheres A and B have radii represented by r a r', and are surrounded by shells, connected together, whose radii are represented by R and R'.

Then—

if $r=100$ and $R=101$ then $R=\frac{101-100}{100\times101}=\frac{1}{10{\cdot}100}=0{\cdot}000099$;

and if $r'=200$ and $R'=201$ then $R=\frac{201-200}{200\times201}=\frac{1}{40{\cdot}200}=0{\cdot}000024.$

Or, the inductive resistance between A and its surrounding shell, is to that between B and its shell, as 99 is to 24; and, consequently, if a charge be imparted to the spheres, the quantity, Q, on A, is to that, Q′, on B, as 24 is to 99.

Now $100^2 : 200^2 :: 24 : 96$,
or $r^2 : r'^2 :: Q : Q'$ nearly.

The smaller the radii of the shells, compared to that of the spheres, the nearer will the inductive resistance be inversely, as the squares of the radii of the spheres, and the nearer will the quantities be directly as the squares of the radii, or directly, as

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* "An Essay on the Application of Mathematical Analysis to the Theories of Electricity and Magnetism." By George Green, Nottingham, 1828. Page 1: "The object of this essay is to submit to mathematical analysis the phenomena of the *equilibrium* of the electric and magnetic fluids," &c. &c.

† This equation is given in Green's Essay thus—

$$\frac{P}{P'}=\frac{a\,(b-a)}{a'(b-a')}.$$

It is evident, however, that the dash on the lower P should be on the upper one instead, else the densities would be *directly* as the radii, which would not agree with the enunciation which follows it. But, moreover, the steps from the equation (1) gives equation (2) as I have given it.

‡ Green has applied his theory in his Essay to a very few problems, but there are some others besides the one I have mentioned which agree strictly with those I have solved in the earlier part of this work, by means of Ohm's law. They do not, however, belong to the subject which I am treating in this chapter, viz., *tension*. I may, perhaps, in a note at the end of this work call attention again to this encouraging coincidence between the results obtained by two very different modes of dealing with the same problem.

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the surfaces of the spheres; and the nearer will the densities be the same on both spheres. And since the quantities on the spheres are directly as the surfaces—

$$\frac{Q}{S}=\frac{Q'}{S'},$$

or the densities are the same on both spheres.

Finally, in such cases, if spheres of different radii are charged separately with given quantities, their tension to their shells will be inversely as the squares of their radii.

All these facts, with regard to spheres, are also clearly illustrated by the geometrical figure, No. 35, on page 196.

Erratum: Page 267, *first column*—

For, if $r =$ unity, then $R = \frac{r'-1}{r'} = r' - \frac{1}{r}$

Read, if $r =$ unity, then $R = \frac{r'-1}{r'} = 1 - \frac{1}{r'}$

(*To be continued.*)

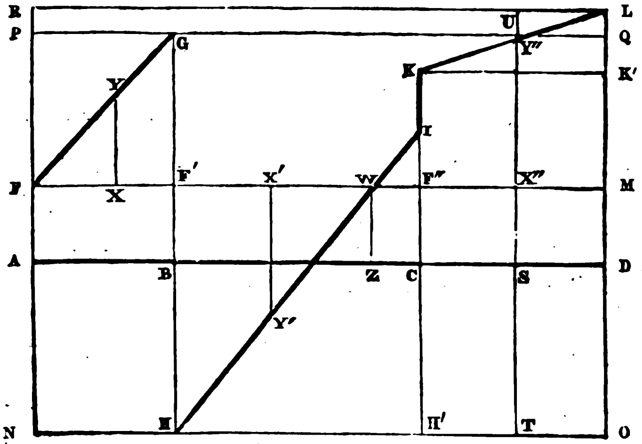
THE GALVANIC CIRCUIT INVESTIGATED MATHEMATICALLY.

BY DR. G. S. OHM.

[Continued from p. 271.]

I WILL now proceed to the determination of the electric force at any given position in every galvanic circuit, and here again I shall lay down as basis fig. 8. For this purpose let a, a', a'' indicate the tensions existing at B C,

Fig. 8.



and between A and D, so that in this case also a and a'' represent additive, a' on the contrary a subtractive line, and λ, λ', λ'' any lines which are directly as the lengths of the parts A B, B C, and C D, and inversely as the products of the conductibilities and sections of the same parts; further, let

$$a + a' + a'' = A$$

and

$$\lambda + \lambda' + \lambda'' = L$$

then according to the law just ascertained

G F′ is a fourth proportional to L, A and λ
I H′ a fourth proportional to L, A and λ'
L K′ a fourth proportional to L, A and λ''.

Draw the line F M through F parallel to A D, regard this line as the axis of the abscissæ, and erect at any given points X, X′, X″ the ordinates X Y, X′ Y′ X″ Y″, we obtain their respective values, thus:

In the first place we have, since A B = F F″

$$AB : GF' = FX : XY,$$

whence follows:

$$XY = \frac{FX \cdot GF'}{AB},$$

or if we substitute for G F′ its value $\frac{A \cdot \lambda}{L}$

$$XY = \frac{A}{L} \cdot \frac{FX \cdot \lambda}{AB}$$

If now x represent a line such that

$$AB : FX = \lambda : x$$

then

$$XY = \frac{A}{L} \cdot x.$$

Secondly, since B C and F′ X′ are equal to the lines drawn through I and Y′ to G H parallel to A D

$$BC : IH' = F'X' : F'H - X'Y',$$

whence

$$-X'Y' = \frac{IH' \cdot F'X'}{BC} - F'H$$

or, since F′ H = G H − G F′

$$-X'Y' = \frac{IH' \cdot F'X'}{BC} + GF' - a.$$

If now for I H′ and G F′ we substitute their values $\frac{A \cdot \lambda'}{L}$ and $\frac{A \cdot \lambda}{L}$, we obtain,

$$-X'Y' = \frac{A}{L}\left(\lambda + \frac{F'X' \cdot \lambda'}{BC}\right) - a;$$

and if by x' we represent a line such that

$$BC : F'X' = \lambda' : x',$$

then

$$-X'Y' = \frac{A}{L}(\lambda + x') - a.$$

Thirdly, since C D = K K′ and F″ X″ is equal to the part of K K′, which extends from K to the line X″ Y″, we have

$$CD : LK' = F''X'' : X''Y'' - KF'',$$

whence

$$X''Y'' = \frac{LK' \cdot F''X''}{CD} + KF'',$$

or, since K F″ = K I + I H′ − F′ H and F′ H = G H − G F′,

$$X''Y'' = \frac{LK' \cdot F''X''}{CD} + IH' + GF' - (a + a').$$

If now for L K′, I H′, G F′ we substitute their values

$\frac{A \cdot \lambda''}{L}$, $\frac{A \cdot \lambda'}{L}$, $\frac{A \cdot \lambda}{L}$, we obtain

$$X''Y'' = \frac{A}{L}\left(\lambda + \lambda' + \frac{F''X'' \cdot \lambda''}{CD}\right) - (a + a');$$

and if by x'' we represent a line such that

$$CD : F''X'' = \lambda'' : x''$$

we have

$$X''Y'' = \frac{A}{L}(\lambda + \lambda' + x'') - (a + a').$$

These values of the ordinates, belonging to the three distinct parts of the circuit, and different in form from each other, may be reduced as follows to a common expression. For if F is taken as the origin of the abscissæ, F X will be the abscissa corresponding to the ordinate X Y, which belongs to the homogeneous part A B of the ring, and x will represent the length corresponding to this abscissa in the reduced proportion of A B : λ. In like manner F X′ is the abscissa corresponding to the ordinate X′ Y′, which is composed of the parts F F′ and F′ X′ belonging to the homogeneous portions of the ring, and λ, x' are the lengths reduced in the proportions of A B : λ and B C : λ' corresponding to these parts. Lastly, F X″ is the abscissa corresponding to the ordinate X″ Y″, which is composed of the parts F F′, F′ F″, F″ X″ belonging to the homogeneous portions of the ring, and λ, λ', x'' are the lengths reduced in the proportions of A B : λ, B C : λ', C D : λ''. If in consequence of this consideration we call the values x, $\lambda + x'$, $\lambda + \lambda' + x''$ reduced abscissæ, and represent them generally by y, we obtain

$$XY = \frac{A}{L} \cdot y$$

$$-X'Y' = \frac{A}{L} \cdot y - a$$

$$X''Y'' = \frac{A}{L} \cdot y - (a + a'),$$

and it is evident that L is the same in reference to the whole length A D or F M as y is to the lengths F X, F X′, F X″, on account of which L is termed the entire reduced length of the circuit. Further, if we consider that for the abscissa corresponding to the ordinate X Y, the tension has experienced no abrupt change, but that for the abscissa corresponding to the ordinate X′ Y′, the tension has experienced the abrupt changes a, a'; and if we represent generally by O the sum of all the abrupt changes of the tensions for the abscissa corresponding to the ordinate y, then all the

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values found for the various ordinates are contained in the following expression:

$$\frac{A}{L} \cdot y - O.$$

But these ordinates express, when an arbitrary constant, corresponding to the length A F, is added to them, the electric forces existing at the various parts of the ring. If, therefore we represent the electric force at any place generally by u we obtain the following equation for its determination:

$$u = \frac{A}{L} y - O + c,$$

in which c represents an arbitrary constant. This equation is generally true, and may be thus expressed in words: The force of the electricity at any place of a galvanic circuit composed of several parts, is ascertained by finding the fourth proportional to the reduced length of the entire circuit, the reduced length of the part belonging to the abscissa, and the sum of all the tensions, and by increasing or diminishing the difference between this quantity and the sum of all the abrupt changes of tension for the given abscissa by an arbitrary quantity, which is constant for all parts of the circuit.

When the determination of the electric force at each place of the circuit has been effected, it only remains to determine the magnitude of the electric current. Now in a galvanic circuit of the kind hitherto mentioned, the quantity of electricity passing through a section of it in a given time is everywhere the same, because at all places and in each moment, the same quantity in the section leaves it on the one side as enters it from the other, but in different circuits this quantity may be very different; therefore, in order to compare the actions of several galvanic circuits *inter se*, it is requisite to have an accurate determination of this quantity, by which the magnitude of the current in the circuit is measured. This determination may be deduced from figure 3 in the following manner. It has already been shown that the force of the electric transition in each instant from one element to the adjacent one is given by the electric difference between the two existing at that time, and by a magnitude dependent upon the kind and form of the particles of the body, viz., the conductibility of the body. But the electrical difference of the elements in the part B C, for instance, reduced to a constant unit of distance, will be expressed by the dip of the line H I, or by the quotient $\frac{I H'}{B C}$; if, therefore, we now indicate by κ the magnitude of the conductibility of the part B C,

$$\frac{\kappa . I H'}{B C}$$

will express the force of the transition from element to element, or the *intensity* of the current in the part B C; consequently, if ω represent the magnitude of the section in the part B C, the quantity of electricity passing in each instant from one section to the adjacent one, or the *magnitude* of the current, will be expressed by

$$\frac{\kappa . \omega . I H'}{B C};$$

or if S represent this magnitude of the current, we have

$$S = \frac{\kappa . \omega . I H'}{B C},$$

and if we substitute for I H' its value $\frac{A . \lambda'}{L}$

$$S = \frac{A}{L} \cdot \frac{\kappa . \omega . \lambda}{B C}.$$

Hitherto the letters $\lambda, \lambda', \lambda''$ have represented lines which are proportional to the quotients formed of the lengths of the parts A B, B C, C D, and the products of their conductibilities and their sections. If we restrict for the present this determination, which leaves the absolute magnitude of the lines $\lambda, \lambda', \lambda''$ uncertain, so that the magnitudes $\lambda, \lambda', \lambda''$ shall not be merely proportional to the said quotients, but shall be likewise equal to them, and henceforth vary this limitation in accordance with the meaning of the expression "reduced lengths," the first of the two preceding equations becomes

$$S = \frac{I H'}{\lambda'},$$

which gives the following generally: The magnitude of the current in any homogeneous portion of the circuit is equal to the quotient of the difference between the electrical forces present at the extremities of this portion divided by its reduced length. This expression for the forcess of the current will be continued to be employed subsequently. The second of the former equations passes, by the adopted change, into

$$S = \frac{A}{L},$$

which is generally true, and already reveals the equality of the force of the current at all parts of the circuit; in words it may be thus expressed: The force of the current in a galvanic circuit is directly as the sum of all the tensions, and inversely as the entire reduced length of the circuit, bearing in mind that at present by reduced length is understood the sum of all the quotients obtained by dividing the actual lengths, corresponding to the homogeneous parts by the product of the corresponding conductibilities and sections.

(*To be continued.*)

NOTE ON THE THEORY OF SPHERICAL CONDENSERS.

BY M. S. M. GAUGAIN.

I have indicated in my preceding communications* a general principl by means of which all questions relative to condensers may be transformed into questions of propagation, and thus brought within the domain of Ohm's law. The exactitude of this principle has been already demonstrated experimentally:—1, in the case of concentric cylindrical condensers; 2, in the case of excentric cylindrical condensers; 3, in the case of plain condensers (*Comptes Rendus*, Feb. 18 April 29, and June 17, 1861.) I have now verified it for a new class of condensers, that of consentrical spherical condensers.

The problem which I proposed to solve was as follows:—Given two concentrical spheres, suppose that the inside sphere, whose radius is r, is placed in contact with a constant source of electricity, and that the external sphere whose radius is R, is placed in contact with the ground; it is required to express the charge of the inside sphere in terms of the radius r and R.

In order to obtain the corresponding questions of propagation, it is sufficient to suppose that the insulating substance, which separates the two spheres in the case of condensation, is replaced by a medium which is a conducter, but to a far less extent than the substance of which the spheres consist. The problem then consists in finding an expression for the intensity of the current transmitted from the internal sphere to the external one; and this latter question is easily solved.

Suppose two concentric spheres very near each other, and having the radius x and $x + d x$ (x being less than R and greater than r); the resistance of the medium comprised between these two spheres will be expressed by $\frac{K d x}{x^2}$, K being a constant coefficient; and this resistance will be the differential of the total resistance of the spherical ring comprised between the spheres of the radius r and x. This total resistance will thus have the value $K\left(\frac{1}{r} - \frac{1}{x}\right)$, that of the ring comprised between the spheres of the radius r, and radius R will be expressed by $K\left(\frac{1}{r} - \frac{1}{R}\right)$, and consequently the intensity of the current transmitted will be proportional to $\frac{R r}{R - r}$. Now, from the principle which I have adduced at starting, the charge expressed in the case of condensation, ought to be proportional to this same expression. It was necessary to ascertain experimentally if this were so.

To do this I have compared, two by two, six concentrical spherical condensers, the armatures of which had the following dimensions:—

	Internal Sphere. Diameter in Millimeters.	External Sphere. Diameter in Millimeters.
No. 1	61·5	89·0
2	61·5	118·5
3	61·5	161·0
4	90·5	118·5
5	90·5	161·0
6	120·0	161·0

I charged these six apparatus successively, by placing them in communication with the same source, and I determined the charge accumulated on the sphere by the methods described in my preceding notes. Through a circular aperture, 30 millions in diameter in each of the external spheres, wires can be introduced by which the sphere is either charged or discharged. The following are the results obtained:—

	Charge obtained experimentally.	Ratio of the Charges obtained.	Ratio of the calculated Charges.
No. 5	16	0·457	0·438
6	35		
3	7·5	0·214	0·211
6	35		
4	27	0·828	0·812
6	32·6		
1	13	0·433	0·424
6	30		
2	10	0·609	0·618
5	16·4		

* See *Philosophical Magazine* Vol XXI p. 539.

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The differences obtained between the calculated and observed charges are small, considering the imperfections of the modes of measurement, and we see that the formulæ deduced from the theory of propagation may be applied to the case of condensation, as well in the case of spherical condensers as in the case of the cylindrical and plane condensers, with which I have been previously occupied. I believe that the proposition may, without temerity, be generalized, and be considered applicable to condensers of any shape.

To appreciate the interest of this principle, it is important to observe that the theory of condensers, which has been usually presented as a branch of statical electricity, comprehends really the whole of this subject. When an insulated and electrified conductor is placed in any room, the electricity with which it is charged is usually called free electricity; but, as Mr. Faraday has shown by numerous experiments, this electricity is no more *free* than that on the inner coating of a Leyden jar. The insulated conductor is only the inner coating of a large condenser, the external coating of which is constituted by the whole of the adjacent conductors. In fine, all questions relating to the distribution of electricity, which is said to be *free*, depend on the theory of propagation. By the principle which I have propounded, all questions of statical electricity may be resolved into questions of dynamics, and *vice versâ*.

The want of apparatus has prevented me from investigating whether the numerous results which Coulomb obtained in his researches relative to the destribution of electricity may be made to coincide with the ideas which I have laid down; but I have already been able to verify the very simple law which expresses the free charge. We have just seen that the quantity of electricity accumulated on the inner coating of a spherical condenser is proportional to $\frac{Rr}{R-r}$. This expression is reduced to r if we suppose R to be infinite, but it seemed evident that if the outer armature becomes infinitely large, its form becomes indifferent. We are thus led to admit, that when a sphere is placed in an envelope which is either infinite or simply very large, the charge communicated to it by a given source is proportional to its radius: which amounts to saying in Coulomb's language, that the thickness of the electric layer is inversely as its radius. To verify this conclusion I took four spheres of brass, the diameters of which were 61·5, 90·5, 120, and 191 millians; I placed them successively on an insulating support in the centre of a very narrow chamber, and charged them by connecting them with a constant source by means of a metallic wire: I then tested them by employing, as usual, a discharging ectroscope. The charges obtained were 5·2, 7·6, 11, and 14·7. The law of proportionality would have given 5·2, 7·6, 10·1, and 13·6. These two series of numbers are not identical; but they differ so little, that we might expect that the law of proportionality would be exactly verified in a larger envelope.

At first we might suppose that this law of proportionality is opposed to one of the results obtained by Coulomb; but this contradiction is only apparent.

In Coulomb's experiment, in the case of two unequal spheres, the spheres touched at the moment at which they were electrified, and were only separated after being charged; their material action, necessarily, modifies the distribution of electricity. The problem I have treated is quite different, and much more simple, as the spheres on which I worked were only charged successively.—*Comptes Rendus*, September 30, 1861.

CATALOGUE OF BOOKS AND PAMPHLETS ON ELECTRICITY, &c.

MR. L. CLARK'S LIST *(continued)*.

1709—HAUKSBEE, Francis, F.R.S..

[Phisico-Mechanical Experiments on various subjects, containing an account of several surprising phenomena, touching Light and Electricity, produceable on the Attrition of bodies, with many other appearances not before observed: together with The Explanations of all the Machines (the figures of which are curiously engraved on Copper), and other apparatus used in making the experiments: By F. Hauksbee, F.R.S. London, printed by R. Brugis, for the Author, and sold only at his house in Wine Office Court in Fleet Street, 1709.] 8vo.

1716—WHISTON, Dr. William, M.A.

[An account of a Surprising Meteor seen in the Air, March 6, at 17⅓ at night, containing: 1, A description of this meteor from the Author's own observations. 2, Some historical accounts of the like meteors before, with extracts from such letters and accounts of this as the author has received. 3, The Principal Phenomena of this meteor. 4, Conjectures for their solution. 5, Reasons why our solutions are so imperfect. 6, Inferences and observations from premises. By William Whiston, M.A. London, printed for J. Senex, at the Globe, in Salisbury Court, and W. Taylor, at the Ship, in Paternoster Row, 1716.] Pamphlet, a few pages.

1719—HAUKSBEE, F.

[Physico-Mechanical experiments on various subjects, containing an account of several surprising Phenomena, touching Light and Electricity, producible on the Attrition of bodies: with many other remarkable appearances not before observed. Together with the explanations of all the machines (the figures of which are curiously engraved on copper), and other apparatus used in making the experiments. To which is added a supplement, containing several new experiments not in the former edition. The second edition by F. Hauksbee, F.R.S. London, for J. Senex, at the Globe, in Salisbury Court; and W. Taylor, at the Ship, in Paternoster Row. MDCCXIX.] 8vo., plates.

1721—WHISTON, William.

[The Longitude and Latitude found by the inclinatory or Dipping Needle; wherein the laws of magnetism are also discovered. To which is prefixed an Historical Preface; and to which is subjoined Mr. Robert Norman's New attractive, or account of the first invention of the Dipping needle. By Will. Whiston, M. A., sometime Professor of the Mathematicks in the University of Cambridge. London, printed for J. Senex, at the Globe, in Salisbury Court, and W. Taylor, at the Ship, in Paternoster Row, MDCCXXI.] Small 8vo.

Rob. Norman's "New Attractive" was published originally about 1574, or 1578, and is the earliest notice of the Dipping Needle.

1723—ROHAULT.

[Rohault's System of natural Philosophy, illustrated with Dr. Samuel Clarke's notes, taken mostly out of Sir Isaac Newton's Philosophy, with additions. Done into English by Sam. Clark, D.D., prebendary of Canterbury, and Chaplain in ordinary to his Majesty. London, printed for James Knapton, at the Crown, in St. Paul's Church-yard, MDCCXXIII.] In two volumes.

Vol. II., Part III., Chap. VIII., Of the Load-stone. Chap. XIV., of Thunder, Lightning, and Thunderbolts.

1726—S'GRAVESANDE, William James's.—

[Mathematical Elements of Natural Philosophy, confirmed by experiments or an introduction to Sir Isaac Newton's Philosophy. Written in Latin, by William James, S'Gravesande, Doctor of Laws and Philosophy, Professor of Mathematicks and Astronomy, at Leyden, and Fellow of the Royal Society of London. Translated into English by F. T. Desaguliers, LL.D., Fellow of the Royal Society, and Chaplain to His Grace the Duke of Chandos. The second edition corrected.—London: printed for J. Senex, in Fleet Street, W. and J. Innys, in St. Paul's Church Yard, and J. Osborn and T. Longman, in Paternoster Row, MDCCXXVI.]—8vo., 2 vols., plates.

Vol. 2, Book III., Part I., Chapter II. "That the fire adheres to bodies and is contained in them; when we shall also speak of electricity."

1742—DESAGULIERS, F.T.—

[A Dissertation concerning Electricity, by F. T. Desaguliers, LL.D., F.R.S., Chaplain to His Royal Highness the Prince of Wales. To which is annexed a letter from President Barbot, Perpetual Secretary of the Academy

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of Bourdeaux, to acquaint him that his dissertation had won the prize proposed, by that Academy, to be given to the person who should write best upon that subject.—London: printed for W. Innys and T. Longman, MDCCXLII.]—Pam., small 8vo.

1744—VAN MUSCHENBROCK, Peter.—

[The Elements of Natural Philosophy, chiefly intended for the use of students in Universities, by Peter Van Musschenbrock, M.D., Professor of Mathematics and Philosophy, in the University of Leyden. Translated from the Latin by John Colson, M.A. and F.R.S., Lucasian Professor of Mathematics, in the University of Cambridge.—London: printed for J. Mourse, at the Lamb, without Temple Bar, MDCCXLIV.]—2 vols., 8vo., plates.

Vol. I., Chapter XVII. "Of Electrical Bodies." Chapter XVIII. "Of the Attraction of Bodies." Treats also of loadstones and magnets. Vol. II., Page 251. Waterspouts.

1746—ANONYMOUS.—

[A Philosophical enqniry into the properties of Electricity. In which is contained a confutation of the solutions which have been hitherto given of it, and the most probable reason of the late surprising experiments. In a letter to a friend.—London: printed for Mr. Cooper, at the Globe, in Paternoster Row, MDCCXLVI.]—Pam., small, 8vo.

1746—FREKE, John.—

[An Essay, to show the cause of Electricity, and why some things are non-electricable. In which is also considered its influence in the Blasts on Human Bodies, in the Blights on Trees, in the Damps in Mines, and as it may affect the sensitive Plant, &c. In a letter to Mr. William Watson, F.R.S., by John Freke, Surgeon to St. Bartholomew's Hospital, London, F.R.S. The second edition, with an appendix.—London: printed by W. Innys, in Paternoster Row, MDCCXLVI.]—Pam., small, 8vo,

1746—MARTIN, Benjamin.

[An Essay on Electricity, being an enquiry into the nature, cause, and properties thereof, on the principles of Sir Isaac Newton's Theory of Vibrating Motion, Light, and Fire; and the various phenomena of forty-two capital experiments; with some observations relative to the uses that may be made of this wonderful Power of Nature, by Benjamin Martin.—Bath: printed for the Author, and Mr. Leake and Mr. Frederick, Booksellers; Mr. Raikes, Printer, at *Gloucester*, Mr. Collins, Printer, at *Salisbury*, and Mr. Newbury, Bookseller, at the Bible and Sun, in St. Paul's Churchyard, *London*, MDCCXLVI.]—Pam., small, 8vo.

1746—MARTIN, Benjamin.—

[A Supplement, containing remarks on a Rhapsody of Adventures of a Modern Knight-errant in Philosophy, by Benjamin Martin.—Bath: printed for the Author, and Mr. Leake and Mr. Frederick, Booksellers; Mr. Raikes, Printer, *Gloucester*, Mr. Collins, Printer, at *Salisbury*, and Mr. Newbury, Bookseller, at the Bible and Sun, in St. Paul's Churchyard, London, MDCCXLVI.]—Pam., small, 8vo.

1746—WILSON, Benjamin.—

[An Essay towards an explanation of the Phenomena of Electricity, deduced from the Æther of Sir Isaac Newton, contained in three papers, read before the Royal Society, by Benjamin Wilson.—London: printed for C. Davies, Printer for the Royal Society, against Grays Inn, Holbourn, and Mr. Cooper, in Paternoster Row, MDCCXLVI.]—Price one Shilling, Pam., Illustrated.

1746—WATSON, William.—

[A Sequel to the experiments and observations tending to illustrate the Nature and Properties of Electricity. Wherein it is presumed, by a series of experiments expressly for that purpose, that the source of Electrical Power and its manner of acting are demonstrated. Addressed to the Royal Society, by William Watson, F.R.S. The second edition.—London: printed for C. Davies, Printer to the Royal Society, against Grays Inn, Holbourn, MDCCXLVI.]—Price one shilling and sixpence. Pamphlet, Illustrated.

1746—WATSON, WILLIAM.—

Experiments and Obsevations, Tending to Illustrate the Nature and Properties of Electricity in one letter to Martin Folkes Esqre., President, and two to the Royal Society, by William Watson F.R.S. The third Edition—London: Printed for C. Davies, Printer to the Royal Society, against Grays Inn, Holborn, MDCCXLVI.] Price one Shilling.

1746—TURNER, R.—

[Electricology, or a Discourse on Electricity, being an enquiry into the Nature, Causes, Properties, and Effects thereof, upon the Principles of the Æther, Illustrated by a Series of Surprising Experiments, Containing everything Curious in this branch of Philosophy that has been communicated by Professor Muschenbrock; Le Monier, L' Abbe Nolet &c. abroad, and by Messieurs Watson, Martin, and other literati at home, with several new and conclusive ones, and particularly the Surprising Phenomenon of the Sensitive Plant and wonderful benumbing property of the Torpedo are herein explained and accounted for By R. Turner.—Worcester: printed for the Author by Thomas Olivers, and sold by S Austen in Newgate Street, and sold by J. Hodges on the Bridge at London; T. Warren in Birmingham, and the aforsaid T. Olivers, 1746].—Pamphlet. Wood Cuts.

ERRATUM: Mr. H. Weaver, of the Electric and International Comprny, has kindly pointed out several errors in the title of the German periodical devoted to telegraphic science, which was mentioned last week. It should be as follows:—Zeitschrift des Deutsch—österreichischen Telegraphen-Vereins Herausgegeben in dessen Auftrage von der Königlich Preussischen Telegraphen-Direction. Redigirt von Dr. P. Wilhelm Brix.—Berlin: Verlag von Ernst and Korn.]—4to., with folding plates.

RECORD OF THE BRITISH ASSOCIATION.

MATHEMATICAL AND PHYSICAL SCIENCE, AND CHEMISTRY.

ON Wednesday, the 8th inst. (Section A), Mr. J. Park Harrison, M.A., read a paper "On Lunar Influence on Temperature."

This paper showed that the evidence derived from the observations of mean temperature, at Greenwich, for the years 1856-62, confirmed the conclusions arrived at from the tabulation of the observations at that station for the last 43 years previous, viz., that the temperature at the moon's first quarter was higher than at full moon or last quarter, and that this is due to the amount of cloud at first quarter being greater than it is at full moon and last quarter. The amount of rain also at first quarter and full moon was shown to have been 7·87 inches in 1861-2, on an average of 84 observations. At full moon it was only 5·60 inches. The sums of mean temperature, during the same periods, were 4,311°·6 at first quarter, and 3,941°·4 at full moon. Mr. Harrison also showed that the differences between the mean temperatures of 208 observations, on two days of the week, Wednesday and Saturday, was only 0°·1, and he contrasted this with the results obtained from an equal number of observations arranged according to the moon's phases, where the result was nearly 3°·0.

In the evening, a general meeting of the committee was held in the Alderman's parlour—Professor Willis in the chair—at which the business of the meeting was wound up, thanks voted to the various private gentlemen, municipal and university bodies that had forwarded the objects of the society, and the association adjourned to meet next year at Newcastle-on-Tyne.

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The meeting, this year, cannot be called a successful one, either as to numbers, splendour, or results. Many complaints are also heard as to the want of comfort, and the extortionate charges met with at Cambridge; and the arrangements of the local committee are severely censured. Several of the papers which have been read will, however, be of considerable interest to our readers; and abstracts of these will be given in our columns.

ABSTRACTS OF PAPERS READ BEFORE THE BRITISH ASSOCIATION.

PROVISIONAL REPORT ON A PROPOSED STANDARD OF ELECTRICAL RESISTANCE: READ BY MR. FLEEMING JENKIN.

This was the provisional report from the committee appointed by the Association, and consisting of Professors A. Williamson, C. Wheatstone, W. Thomson, W. Allen Miller, Mr. A. Matthiessen, and Mr. F. Jenkin. Five qualities were enumerated as desirable in the proposed standard:—1. It should be of convenient magnitude. 2. It should form part of a coherent system for general electrical measurement. 3. It should bear a definite relation to the unit of work. 4. It should be unalterable. 5. It should be reproducible. None of the units hitherto proposed fulfilled all these conditions. Those based on an arbitrary length and section, or weight of some arbitrary material, did not possess the second and third qualities. The absolute system possessed these, but failed in the fourth and fifth qualities. A system proposed by Sir Charles Bright and Mr. Latimer Clark failed in the third point. The committee could not, therefore, recommend the unqualified adoption of any of the units hitherto proposed. They recommend that a material standard should be prepared of such form and materials as would ensure the most absolute permanency; that this standard should approximate very nearly to 10^{10} absolute $\frac{\text{meter}}{\text{seconds}}$ (this magnitude does not differ by more than 3 per cent. from Dr. W. Siemen's mercury unit); that, instead of being called the absolute unit, it should be known as the unit of 1862, or by some simpler name; but from time to time, as the advance of science renders this possible, the difference between this unit and the true ten millions of $\frac{\text{meter}}{\text{seconds}}$ should be ascertained with increased accuracy in order that the error resulting from the use of the 1862, in dynamical calculations, instead of the true absolute unit, may be corrected by those who require these corrections; but that the material standard itself shall, under no circumstances, be altered in substance or definition. Before carrying out these views, the Committee felt that they should be in a position to secure a very considerable approximation to the absolute unit, and to ensure great permanency in the material standard. The experiments connected with these two points are in progress, and it is hoped that before Christmas the fresh determination of the absolute unit, checking Professor Weber's results, will be completed, and that provisional standards may then be distributed to all who require them. Reports from Prof. Williamson and Mr. Mathiessen were appended, and letters from Prof. Kirchhoff, Dr. W. Siemens, and Dr. Esselbach; and also a description of an accurate apparatus for the adjustment or multiplication of resistance coils designed by Mr. F. Jenkin.

Recent Patents.

538. Sir C. T. Bright, *Victoria Street, Westminster*, "*Improvements in Electric Telegraphs, and in Apparatus connected therewith, and employed in the manufacture thereof.*"—*Dated 27th February*, 1862.

In the First part of this invention, which has reference to the receiving apparatus, or relay, the patentee employs conducting fluids in a state of motion, into which the moveable part of the relay is inserted or removed in order to make or break local or secondary circuits, so that the conducting surface with which contact is made or broken is constantly changed; and he prefers for this purpose a fine stream or fountain of mercury, or acid and water. He also employs a series of streams or fountains of conducting fluid, the motion of the moveable part or parts of the receiving apparatus among them causing various degrees of motion of such moveable part or parts to be marked upon a suitable recording apparatus included in a local circuit. In the Second part of the invention, which has reference to registering or recording the effects of electrical currents, he employs a band of paper drawn on by a train of clockwork, or any other convenient motive power, and he causes a colouring fluid or fluids in a state of motion to impinge upon the paper, and thus to mark a line, or a series of lines, upon the paper. The line or series of lines is broken from time to time through the colouring fluid being intercepted by an arm or arms moved by the electric currents; and thus the duration of the currents or their variation of force, may be directly recorded upon paper; and for registering the effect of earth currents he employs the clockwork train, carefully regulated as regards its speed of motion, so that the times of any deflections may be noted upon the paper. The Third part of the invention has reference to the sending apparatus, whereby currents are communicated to the conducting wire, and consists of a key which is similar in its manipulation to the lever keys commonly employed for sending currents in working the recording telegraph. Upon the same base as the is fixed a small arm or lever pressed upwards by a spring, but restrained by the greater force of the larger spring of the key when the latter is in its place of rest. The arm is centred loose upon the axle of a small toothed wheel, which it drives by means of a click when it is rising on being released by the motion of the key, but not when it is being pressed down by the key coming back to its place of rest. The toothed wheel gears into the pinion of another small wheel, which drives a fan, the vanes of which are capable of adjustment. The arm is thus controlled in its speed of upward motion by the fan. An adjustable stud limits the amount of motion of the arm. On the key being pressed down in sending a current, the arm begins to rise, and according to the length or nature of the line to be worked, so is the period at which it comes into contact with the stud adjusted; when this takes place, or when the key again comes into contact with the arm in returning to zero, the battery is withdrawn from the line circuits. By this means a longer interval takes place after a long signal than after a short one, although the operator is manipulating the key with the usual pauses all of equal length, irrespective of the signals sent; and when once the rate of motion of the arm has been properly adjusted to the requirements of the line which is being worked, the signals will come out at the other end with equal spaces, and at a higher speed, than the systems at present in operation admit of. The Fourth part of the invention consists in applying protecting or preservative substances in a warm or plastic state to the outside of submarine and other electric telegraph cables or conducting wires by means of a wheel, roller, or circular brush, one part whereof runs in the substance employed, to coat the outside of the cable or wire, while the cable or wire runs upon the upper side and is coated without passing through the substance, whereby all danger of the insulating material being injured by heat (in case of the machinery requiring to be stopped) is avoided, or the cable or wire may be passed between two brushes or rollers. According to the Fifth part of the invention he passes submarine and other cables or wires, after the application of any protecting or preservative substance, between rollers having grooved surfaces adapted to the size of the cable, so that the preservative substance or compound, and any yarn, canvas, gutta percha, or india rubber strips or tapes which may be used together with it, either warm or in a cold state, are compressed together into a solid mass, filling up all inequalities or interstices in the outside of the cable, and making the exterior coating smooth and regular throughout its length. The Sixth part of the invention has reference to cases where, from the surface of the cable to be covered being very irregular (as in the case of a large cable covered with strands of wire), or when from other reason, it is desirable to pass a cable directly through any protecting substance in a heated state. He then causes the cable to be raised out of the substance, upon the stoppage of the machinery by a sheave at the end of a lever being lifted through the convergence of a pair of heavy governor balls, whereby any danger of the cable being heated by the machinery stopping is avoided. The Seventh part of the invention consists in covering submarine and other telegraphic cables or wires with such cements, mortars, or limes as set and become solid under the influence of water, and also surrounding such substances, when necessary, with a serving of yarn, canvas, gutta percha, or caoutchouc strips, or other material, to retain the substance upon the cables or wires during and after the process of manufacture, with or without any saturation of bituminous or other preservative compounds. In the Eighth part of the invention he coats the conducting wire with a covering or coverings of gutta percha, and he surrounds this with a covering or coverings of caoutchouc, and he coats the whole with gutta percha.

562. A. E. Ragon, *Bernard-street, Russell-square, London*, "*Electric Alarums for Telegraphic Purposes.*"—*A communication.—Dated* 1*st March*, 1862.

This invention consists in constructing electric alarums with differential wires, for the purpose of destroying all residuary magnetism, and for rendering the said instrument so delicate and sensitive as to obtain, during the transmission of the electric current, the maximum of effect of the "line battery." This destruction of the residuary magnetism dispenses altogether in this alarum with the necessity for employing any kind of regulating or winding mechanism, at the same time the adjustment of the alarum is not in any way deranged or affected by the wood stand on which the alarum is mounted and fixed.

Orders have been received at the head-quarters of the Royal Engineer establishment, Chatham, from the department of the Deputy-Adjutant-General, directing the detachment of Royal Engineers selected to proceed to New Zealand, to form the surveying expedition in that colony, to be held in readiness to embark for their destination on the 20th inst. The men selected for this duty are those who have gone through a complete course of telegraphy, under the direction of Capt. Schaw, the head of the telegraphic department at the Royal Engineer establishment. The party will take out a complete telegraph apparatus, the want of which has been for a long time felt in the colony.

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AN ACCOUNT OF RESEARCHES IN ELECTRO-CHEMISTRY.

BY PROFESSOR SCHÖNBEIN, OF BASLE.*

The British Association for the Advancement of Science, at their last meeting in Birmingham, honoured me with the charge to undertake a series of experiments, with the view of extending the limits of our knowledge on the connection which is supposed to exist between electrical and chemical phenomena. The memoir which I now take the liberty to lay before the Association, contains an account of the results of my late investigations, many of which may, perhaps, appear as not immediately bearing upon the subject in question; but I think them, nevertheless, closely connected with it. It must, however, not omit to say, that my task is still very far from being accomplished.

It is familiarly known, that a peculiar odour, resembling that of phosphorus, is developed whenever common electricity passes from metallic, or any other conducting points, into atmospheric air; but I am not aware of having seen it anywhere stated, that a similar odour is disengaged during the electrolysis of water, though there can be no doubt that, besides myself, more than one philosopher has observed that phenomenon. The complete ignorance in which we still remain of the true cause of the electrical smell, and of the appearance of the latter under circumstances apparently so different from each other, cannot fail to excite scientific curiosity to a high degree, and stimulate philosophers to employ all their experimental means and mental powers to clear up the mysterious phenomenon. My own endeavours to solve the problem have been manifold, and for a long time were fruitless; at last, however, I succeeded in ascertaining some facts which promise to throw light upon the subject in question. Respecting the disengagement of the electrical odour during the electrolization of water, as well as during the passage of common electricity from points into atmospheric air, my researches have led to the following results:—

1. The peculiar smell makes its appearance as soon as the electrolization of water begins, and continues to be perceived for some time after water has ceased to be decomposed.

2. The phosphorus smell is produced at the positive electrode only, and under no circumstances whatsoever at the negative one; for when the gases resulting from the electrolysis of water are received in separate vessels, the smell is perceived only in that which contains oxygen.

3. The odoriferous principle can be preserved in well-closed vessels for a great length of time, whether mixed with oxygen or with detonating gas.

4. The disengagement of the smelling substance depends—

(*a*) Upon the nature of the positive electrode.

(*b*) Upon the chemical constitution of the electrolytic fluid, and

(*c*) Upon the temperature of that fluid.

With regard to the circumstance mentioned under (*a*), my experiments have shown that it is only well-cleaned gold and platina which are capable of disengaging the odoriferous principle. The more readily oxydable metals, as well as charcoal, do not possess that property at all.

It is worthy of remark, that iron, though acting (agreeably to my former experiments) like gold and platina, when performing the function of the positive electrode, does not permit the disengagement of the odour.

As to the condition mentioned under (*b*), I have ascertained that the odoriferous principle is obtained from distilled or common water, when mixed with chemically pure, or with common sulphuric acid, with phosphoric acid, nitric acid, potash, and a series of oxy-salts. I could not get a trace of it from aqueous solutions of chlorides, bromides, iodides, fluorides, hydro-chloric acid, hydro-bromic acid, hydriodic acid, hydro-fluoric acid, sulphate of protoxide of iron. If, to the fluids (above mentioned) which permit the disengagement of the peculiar smell, small quantities of nitrous acid, iron vitriol, proto-chloride of iron or tin are added, not the least portion of the odoriferous principle will be given out, however actively water may be electrolized. With regard to the aqueous solution of potash, I have observed the curious fact, that the smell is sometimes disengaged from it, and sometimes not; the latter case occurring much more frequently than the former. I do not know yet the cause of that anomaly.

Concerning the influence which temperature exerts upon the development of the peculiar smell, I have found that a fluid from which the odoriferous principle is abundantly disengaged at a comparatively low temperature, does not yield a trace of it when heated near its boiling point. I must not omit to state, that dilute sulphuric acid is the fluid best fitted for producing the smelling substance, and making the experiments which the memoir refers to. It sometimes happens, however, that even in making use of that fluid, the disengagement of the odoriferous principle is either suddenly stopped, or does not take place at all. In such cases, the surface of the positive gold or platina electrode is not pure, *i. e.*, it is covered with some foreign substance; and, to cause the re-appearance of the peculiar smell, it is necessary to clean that electrode, which, by my experience, is best done by washing it first with pure muriatic acid, and afterwards with distilled water.

5. If some pinches of powdered charcoal, iron, tin, zinc, or lead filings, or of powdered antimony, bismuth, and arsenic, or some drops of mercury are thrown into a bottle containing the odoriferous principle (mixed with oxygen), the peculiar smell disappears almost instantaneously. Iron and charcoal seem, however, to act more rapidly than the other substances mentioned do; gold and platina, when strongly heated, also destroy the smell. Small quantities of nitrous acid and aqueous solution of proto-chloride of iron, sulphate of protoxide if iron, and proto-chloride of tin, being put into a vessel containing our peculiar principle, do likewise instantaneously annihilate the phosphorous smell.

6. A gold or platina plate, after having been kept only for a few moments within a vessel containing the odoriferous principle (mixed with oxygen), appears to be negatively polarized. To excite that polar state in the metals mentioned, it is a condition, *sine qua non*—

(*a*) That the surface of the plate of either metal be absolutely clean, and entirely free from moisture.

(*b*) That the temperature of the metal be comparatively low. Heated gold or platina does not assume the negative polar condition. The current produced by such a polarized metal is of so short a duration, that it may be considered as instantaneous. Among the metals more readily oxydable than gold or platina, it is only silver and copper that are rendered negative by being put into an atmosphere of the odoriferous principle; but the degree of polarity acquired by these metals is exceedingly slight.

7. Gold and platina having been polarized in the manner indicated. maintain their peculiar condition for some length of time when placed in common air. I have found plates which had been exposed to the atmosphere, at least for a couple of hours, still perceptibly negative.

8. A polarized stripe of gold or platina loses, almost instantaneously, its negative condition, when plunged into an atmosphere of hydrogen. If the metal is kept in hydrogen longer than just required for destroying its negative polarity, it assumes, according to my former experiments, a positive condition. It will hardly be necessary to mention, that heat also destroys the polarity in question.

9. Oxygen obtained by the electrolysis of water, and deprived of its peculiar smell by the means indicated under § 5, has altogether lost its power of rendering gold and platina negative, and is, in a voltaic point of view, as inactive as oxygen prepared in the usual way.

Phenomena of Polarisation caused by common Electricity.

10. A gold or platina plate, having a perfectly clean and dry surface, assumes negative polarity when exposed to the action of a positive electrical brush issuing from a metallic or any other conducting point. The longer the brush is playing upon the surface of the metal, the higher will be the degree of polarity acquired by the gold or platina. A small platina stripe, after having been exposed to the action of a brush produced by thirty turns of my electrical machine, deviated the needle of a delicate galvanometer by 60°; sixty turns, under the same circumstances, caused a deviation of 90°. It seems that the nature of the metal which performs the function of a point of emission, also exerts some influence upon the degree of polarity acquired by gold and platina. *Cæteris paribus*, a point of emission consisting of gold caused a deviation of 170°, a point of brass only one of 60°. As to the metals (more readily oxydable than gold or platina), I have only succeeded with silver and copper in polarizing them negatively by common electricity. The degree of polarity acquired by the last-mentioned metals is, however, also exceedingly slight.

11. The negative electrical brush produces exactly the same voltaic effects as the positive one does.

12. A platina plate, polarized either by the positive brush or by the negative one, loses its electro-motive power when plunged only for a few moments into an atmosphere of hydrogen. All the remarks made under § 8 also apply to the case in question.

13. If gold or platina plates are connected with the prime conductor of an electrical machine, *i. e.* made points of emission, they will not

* Reports of the British Association for the Advancement of Science.

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assume any polar condition, however long and lively a brush may have been issuing from them.

14. Heated or moistened gold or platina plates, cannot be polarized by the electrical brush.

15. If the points of emission are heated or moistened, the electrical brush issuing from them has no longer any polarizing power. It was impossible to excite in gold or platina even the slightest degree of negative polarity by holding these metals ever so long against a brush issuing from heated or wetted points.

16. The electrical brush proceeding from heated or moistened points does not produce the well-known phosphorus smell. The easiest way of depriving the brush of its smell, is to cover the point of emission with a piece of moistened linen.

Now in what manner are we to account for the facts above stated, and what are the inferences to be drawn from them?

As to the smell being developed at the positive electrode during the electrolysation of water, we can hardly help drawing, from the experiments mentioned in the first section, any other conclusion than that it is due to some gaseous substance disengaged (conjointly with oxygen), from the electrolytic fluid by the decomposing power of the current. But what is the nature of that substance? Is it elementary or compound? With regard to its voltaic bearings, it exhibits the strongest analogy to chlorine and bromine; of which bodies I proved, some time ago, that they possess, to a high degree, the power of negatively polarizing gold and platina. I have also formerly shown, that these metals lose again their negative polarity acquired under the influence of chlorine and bromine, when plunged into an atmosphere of hydrogen; there is, consequently, not the least doubt that, as to its electro-motive power, the odoriferous principle bears the closest resemblance to chlorine and bromine. Now, does not this great analogy between the voltaic properties of chlorine, bromine, and our smelling principle, speak in favour of the supposition, that these three substances belong to the same class of bodies, *i. e.* to those which Berzelius called "halogenia?" If we take into further consideration the facts, (*a*) that most metals destroy the peculiar smell, that is, combine with the odoriferous principle in a direct manner, and even at a low temperature; (*b*) that the said principle is not disengaged at the positive electrode, unless the latter be composed of gold or platina; that is to say, of an eminently electro-negative metal; (*c*) that the odoriferous body is not eliminated by the current, if the electrolytic fluid happens to contain a substance having a strong affinity for oxygen, for instance, sulphate of protoxide of iron; and (*d*) that our peculiar principle is always set free at the positive electrode, and never at the negative one; I say, if we duly consider all these facts, we can hardly help drawing from them the conclusion, that the odoriferous substance is a body very like chlorine or bromine. The odoriferous principle, however, may, perhaps, be nothing but a secondary result of the electrolytic action. Such is, no doubt, possible; and, indeed, it was the first view I took of the case. The following reasons, however, seem to speak against the correctness of such a supposition. As chemically pure water (or what we take as such), mixed with sulphuric, nitric, and phosphoric acids, with potash and many oxy-salts, yields the odoriferous principle, we must conclude that the latter proceeds from water, and not from the other substances. Now, what secondary product does water allow to be formed at the positive electrode? The oxygen being eliminated at the latter, might certainly combine with some water, and produce per-oxide of hydrogen. But this compound is not gaseous at the common temperature, and its vapour is wholly inodorous. I have besides, observed, that platina enveloped in a film of per-oxide of hydrogen, is positive to common platina. From these facts it follows, that the odoriferous principle cannot be per-oxide of hydrogen. Or does another, perhaps, exist, consisting of hydrogen and oxygen, and containing more of the latter element than the per-oxide does? Are, perhaps, even chlorine and bromine compounds of a similar description? The per-oxides of manganese, lead, and silver, exhibit the same voltaic properties as chlorine and bromine, both groups of bodies being eminently electro-negative. Such a strong analogy, does it not indicate a similiarity as to their chemical constitution? I do not venture to answer any of these questions. The present state of chemical science does not yet warrant us to speak of chlorine and bromine as of compounds, and I shall, therefore, consider the odoriferous principle as an elementary body, and call it "Ozone," on account of its strong smell.

Now, if we take it for granted that ozone is an elementary substance, and knowing that it originates in water, we must conclude that this fluid is made up of two electrolytes, one consisting of hydrogen and oxygen, the other of ozone and some electro-positive body. When a current is made to pass through such a fluid, both electrolytic compounds are decomposed, their anions, oxygen and ozone, being evolved at the positive electrode, their cations at the negative one. As to these cations, we know well enough that one of them is hydrogen. But is ozone also, like oxygen, united with hydrogen? All the experiments I have hitherto made, with the view of discovering in the gas evolved at the negative electrode something besides hydrogen, have led to negative results, a circumstance which seems to prove that ozone, as met with in water, is combined with hydrogen.

I do not, however, yet consider this point as definitively settled. That, what we call pure hydrogen, is capable of rendering gold and platina electro-positive, seems to me so extraordinary, and so important a fact with regard to the chemical theory of galvanism, that I cannot but recommend it to the full attention of philosophers. Why, indeed, should a piece of platina, being surrounded with a film of hydrogen, and voltaically associated with common platina, produce a current when plunged into pure water? Which is the chemical action that possibly can take place under such circumstances? According to the present state of our chemical knowledge, it is very difficult, if not impossible, to give a satisfactory answer to that question. Has, perhaps, all the hydrogen hitherto prepared not been chemically pure, and does it always contain a principle still more electro-positive than hydrogen itself, that is, having a greater affinity for oxygen than hydrogen has? Careful experiments alone can decide these important points.

The fact above stated, that ozone is not developed at the positive electrode, unless the latter be either of gold or of platina, is, in my opinion, very easily accounted for. These metals having, at the common temperature, very little affinity for ozone, do not combine with it, any more than they do with oxygen in the same circumstances, whilst the other metallic bodies readily unite with the odoriferous principle.*

At a high temperature, gold and platina appear to be capable of combining with ozone;† and this property seems to account for the fact, that from heated dilute sulphuric acid, for instance, the smelling substance cannot be disengaged. It is, however, possible that ozone, in the moment of its being eliminated by the current, reacts upon the heated water, combining with the hydrogen of the latter.

The fact, that no ozone is set free, if the electrolytic fluid happens to be mixed with some readily oxydable substance, with iron-vitriol, for instance, seems to depend upon a decomposition of water, the oxygen of the latter uniting with the protoxide of iron, and its hydrogen with ozone. The non-appearance of the latter is, indeed, very easily understood, if we suppose its action to be entirely analogous to that of chlorine and bromine.

Before proceeding to the discussion of other facts, I must say a few words on the polarising influence exerted by ozone upon gold and platina. In former papers I have endeavoured to prove, experimentally, that certain voltaic conditions which some metals (placed under given circumstances) seem to assume, are not to be considered as real modifications of those metals themselves (a view still maintained by some philosophers), but as changes proceeding only from certain substances being in some way or other deposited upon those metallic bodies. If, for instance, platina becomes positively polarized in an atmosphere of hydrogen, and negatively in one of chlorine or bromine, that metal itself does not undergo the least change with regard to its natural voltaic properties; and it is only the film of hydrogen or chlorine that surrounds the metal, which is to be considered as the seat of the electro-motive power, or as the cause of the polarity. Exactly the same remarks apply to the negative polarity, which gold and platina seem to assume when put into an atmosphere of ozone. By a sort of capillary action that substance adheres to the metal, and the latter being voltaically associated with another piece of the same metal (in its natural state), and plunged into water, the latter will be acted upon by ozone just in the same manner as under similar circumstances it would be by chlorine or bromine. The film of ozone covering the platina will unite with the hydrogen of water, and produce by that action a current. This current will last until all the ozone adhering to the platina stripe unites with hydrogen, but the quantity of that principle being exceedingly small, the duration of the current cannot be long.

Having fully developed my views on the chlorine and bromine circuits, in the *Philosophical Magazine* (August, 1839), and everything said there applying to an ozone arrangement, I have no occasion to enter into further details respecting this branch of the subject.

As to the depolarizing action which an atmosphere of hydrogen exerts upon gold and platina when negatively polarized by ozone, it, perhaps, may depend upon the combination of the latter with hydrogen. In order to account for the disappearance of the polar state, it is, however, not necessary to presume the taking place of such an action.

* See § 5.

† Ibid.

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As platina becomes positively polarized by hydrogen, and negatively by ozone, it is obvious that the opposite voltaic actions of these two elements must, under certain circumstances, exactly balance each other.

It is manifest that the facts considered throw a new light upon what is usually termed negative voltaic polarization. The results which I obtained some time ago on that subject are pretty generally known. They seemed to prove that the negative polar state assumed by the positive electrode in water (holding oxy-acids dissolved) is due to a film either of oxygen or of per-oxide of hydrogen. To the same cause I was inclined to ascribe the negative polarity excited in that portion of acidulated water which is near to, or in contact with, a positive electrode. From the facts above stated, it now appears that, in both cases, the negative polarity results from the presence of ozone. Indeed, water charged with that principle is negative to pure water, whilst the same fluid holding oxygen dissolved is, in a voltaic point of view, inactive to pure water. Water mixed with some per-oxide of hydrogen bears to common water the same voltaic relation as zinc does to copper. Without having recourse to actual electrolyzation, we may indeed produce, by means of insulated ozone, all the phenomena of negative voltaic polarization, a fact which seems to prove the correctness of the explanation offered of the phenomena in question.

I also suspect that the peculiar condition of iron, or its inactive state, has something to do with ozone; but, for the present, I cannot enter into that subject.

It is now time to speak of the phenomena of polarization produced by the agency of the electrical brush. On comparing them with those called forth by ozone, we cannot but perceive a strong analogy between both series of phenomena. The very same metals which become negatively polarized by ozone, are brought into a similar state by the action of the electrical brush. The same conditions to be fulfilled, in order to polarize gold and platina by ozone, are likewise requisite to render these metals negative by the agency of common electricity. The negative polarity developed by ozone is destroyed by the same means by which we annihilate the negative polar state called forth by the brush. These facts are sufficient to countenance the conjecture, that the cause of the negative polarity is in both cases the same, *i. e.* that it is a film of ozone surrounding the metals. I have stated (§ 16), that the brush can easily be deprived of its peculiar smell, and that by so doing the former loses its polarizing power. This fact clearly proves that it is not the electrical brush or discharge itself that excites in the metals exposed to its action the negative polar state, but the odoriferous principle accompanying the brush. This principle affecting our olfactory nerves precisely in the same manner, and also producing the same voltaic effects as ozone does, are we not entitled to infer that the smelling matter in the electrical brush, and the odoriferous principle evolved at the positive electrode, are identical bodies? It appears to me that they are, and I do not, therefore, hesitate to ascribe the familiar electrical odour to ozone.

But how does it happen that ozone makes its appearance, whilst common electricity is passing from the points of a charged conductor into the atmosphere? To account for such a remarkable fact, we certainly must suppose that there is an electrolytic compound present in the air, as well as we suppose one to be contained in water, and that the electro-negative constituent, or the anion of that electrolyte, is our ozone. The passage of electricity from the points of charged bodies into the surrounding air, being in fact nothing but the act of the restoration of a broken electrical equilibrium, or a current, it is not difficult to conceive how ozone is set free near the points of emission. Our supposed electrolyte being present in the atmosphere, requires only to be placed within the circuit of such a current in order to be electrolysed, or to have its anion, ozone, separated from its cation. If all these suppositions be correct, it follows that the electrolysis of our ozonic compound will be most vigorous where the emission of electricity is most abundant, and that consequently, at such a spot, the strongest smell of ozone will be perceived, and platina or gold acquire the highest degree of negative polarity. Now experiments prove that such is really the case.

That the peculiar odour perceived when any terrestrial object is struck by lightning, has something to do with ozone, cannot be doubted. We have been hitherto profoundly ignorant of the nature of that odour, and everything said and conjectured about it by ancient and modern philosophers, must, in my humble opinion, be considered as totally unfounded. We know the fact only, and nothing more. The smell produced by ligthning is usually described as being either sulphurous or phosphorous. Twice in my life I had an opportunity to observe this odour, once in the church of my native place (Mezingen, in Wurtemberg), many years ago; another time in my own house at Basle, only last summer. The second case being still fresh in my memory, I shall say a few words about it. The object struck by lightning was a small chapel situated on the middle of the bridge of the Rhine, and about 200 yards distant from my lodgings. Immediately after the stroke had taken place, not only my house, but also the houses of my neighbours, were filled with a bluish vapour, and a pungent smell was perceived. Six hours after the occurrence, I entered into a parlor which had not been opened all the day, and I could still perceive the peculiar odour. My testimony is certainly not wanted to establish the fact, that lightning always causes the disengagement of an odoriferous principle; but I think that, on account of the great mystery which is still hanging over that phenomenon, the number of observations and statements about it cannot be too much increased. The fact related offers, besides that peculiar interest, that the smell was perceived at a comparatively great distance from the object struck by lightning. As far as my observations go, they incline me to consider the odoriferous gaseous substance set at liberty by the agency of lightning as ozone. Lightning being the same phenomenon on a large scale as the electric spark or brush is on a small one, and our supposed electrolytic compound penetrating the whole atmosphere, electrolysis must take place, and consequently ozone be disengaged to a considerable amount, as often as lightning crosses our atmospheric air. The assertion of some observers, that the odour is of a sulphureous kind, and the statement of others, comparing it with the smell of phosphorous, may easily be reconciled to each other; for I have remarked that ozone, when somewhat condensed, is rather pungent, whilst the same substance mixed up with a large quantity of air, possesses a phosphorous smell. It is well known that the generality of people any pungent odour sulphureous. Hence, if it happens, that the odoriferous principle set free by lightning reaches the observer in a condensed state, he will describe it as sulphureous; but, like phosphorus when inhaled, mixed up with a good deal of air. Hence it follows, that the nearer the observer happens to be placed to the spot where a stroke of lightning takes place, the more pungent will be the smell perceived by him. The property of platina to assume negative polarity in a medium containing free ozone, seems to offer an excellent means to ascertain the presence of that principle in the atmosphere. It appears, therefore, to be desirable to make experiments on that subject, and to place, for that purpose, platina stripes (not being insulated) in elevated regions, particularly on days when thunder-storms are taking place.

Before closing this paper, I must not omit to put a question of some importance. Does the electrolytic compound mentioned exist in our atmosphere quite independent of its aqueous vapour, or is it (the electrolyte) carried into the air by the evaporation of water? It is a matter of course, that this question can only be answered by experiments, and I have not yet found time enough to make them. Supposing the electrolyte to be carried into the atmosphere by the evaporation of water, the electrical brush should not produce any smell when passing into absolutely dry air, and the quantity of ozones disengaged would, *cœteris paribus*, be proportioned to the quantity of aqueous vapour present in the atmosphere; *i. e.* would depend upon the hygrometric state of the latter. It is hardly necessary to say, that problems of the highest scientific importance would be raised, in case it should turn out that ozone can be produced in dry air. Be that, however, as it may, the ubiquity of our electrolyte can hardly fail acting a most important part in the household of nature; and it is not impossible that the electrical phenomena taking place within our atmosphere, the real cause of which is still covered in darkness, are closely connected with the workings of our presumed compound.

The fact of philosophers having not yet had the slightest notion of the existence of such a body is, I presume, no argument against its existence. If we suppose the electrolyte in question to be a substance closely resembling water in its chemical and physical properties, and existing in the latter fluid as well as in the atmosphere, only in very small quantities, it is easily conceivable why its existence has not hitherto been observed. I readily allow, however, that many researches, many experiments, must still be made before we arrive at certain results—at complete certainty—regarding the subject of ozone. Convinced, as I am, of its great scientific importance, I shall not fail devoting all my leisure time to its close investigation, and to sifting a matter to the bottom which promises to yield so rich a harvest of results. I should feel, indeed, very proud, if the British Association would honour me with the charge to present them an account of my researches next year.

It would not be right if I did not expressly state, before finishing my paper, that I owe most of the results above mentioned to a pile constructed upon my friend Mr. Grove's principle, an arrangement which cannot be too highly thought of.

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PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

Fine Para	2s. 1d.	per lb.
Negro	1s. 3d.	"
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Ordinary Reboiled	10d.	"

A very considerable business has been done in both articles and very firm at the quotations.

October 15, 1862. WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic, A.	100	54 to 57	———
20	Do. B 7 per cent. till 1862 .	all	19 to 21	———
20	Do. C	all	———	———
Stock	Electric Telegraph . .	100	100 to 103	———
25	Do. New	20	———	———
5	London District Telegraph .	4$\frac{3}{4}$	4 to 3 dis.	———
10	Lond. & S. Ireld. Direct Tel.	2	——— pm.	———
10	Mediterranean Extension Tel.	all	3 to 4	———
10	Do. 8 per cent. pref.	all	———	———
1	Submarine Telegraph, scrip.	all	$\frac{3}{8}$ to $\frac{5}{8}$	———
1	Do. registered . . .	all	$\frac{3}{8}$ to $\frac{5}{8}$	———
10	Do. " . . .	all	4 to 6	———
2	Telegraph to India . .	1	$\frac{5}{8}$ to $\frac{3}{8}$ dis.	———
5	United Kingdom Telegraph .	8	$\frac{1}{2}$ dis. to par.	———

EFFECTS OF VOLTAIC ELECTRICITY IN RESTORING ANIMAL LIFE.

***Extracted from* MR. W. H. HALSE'S *Address to the Newton Society for the Attainment and Diffusion of Knowledge, dated March* 3, 1840.**

ON Thursday last one of my spaniels whelped, having a litter of thirteen; six of which I took for my experiments. I drowned three of them in cold water, and kept them immersed for fifteen minutes, at which time I took them from the bucket and placed them in front of a good fire; no motion could be perceived in either of them. I then put the front legs of one of them in a jar containing a warm solution of salt and water, and its hind legs in a similar jar, in each of which was inserted one pole of the galvanic battery; the whole was then placed near the fire.

The position of the dog being now favourable for operating on, without the necessity of making any incisions in the flesh, I passed a very strong shock through its body; it moved its hind legs; I gave it another shock, which caused its tail also to move; I now passed twenty shocks in quick succession through its body: it moved every limb, its mouth opened, and I was inclined to believe that the dog had actually come to life; but the moment I ceased passing the shocks, the dog was as motionless as it was previous to my commencement. Again I continued the shocks, and I noticed that there was more motion in the limbs: considering that in proportion to the return of sensibility, that these shocks would be too powerful for it, I decreased the intensity of them, and passed many hundreds in rapid succession. I continued this for about five minutes—the motion of the limbs increasing as the shocks increased in number—I now ceased; the dog still moved—it was restored to life. I placed it on a warm flannel in front of the fire, and in a very short time it appeared as well as it was previously to its being drowned; it crawled on the flannel and made the noise peculiar to young dogs. I now examined the two other dogs which were drowned and taken from the water at the same time that this one was. They were both dead—a plain proof that it was entirely owing to the galvanic fluid that life was restored.

The other three dogs I drowned in warm water, and kept them immersed for forty minutes, at which time all motion had ceased; two of them I laid in front of the fire, and the remaining one I placed in the jars, as in the preceding experiment. I now passed a few shocks of weak intensity through the body, but no motion was perceptible; I therefore increased the intensity of them considerably, and gave the shocks in quick succession. Every limb moved, the belly protruded and again collapsed, and the head was raised. At this period I stopped passing the shocks, in order to see if there were any motion in the dog, when not under the galvanic influence—there was none. I again proceeded with the shocks, and having noticed that the limbs moved more rapidly than before, I considered it necessary to decrease the intensity and increase the quantity of electric fluid, which I did, so much as just to be enabled to perceive a slight tremor in the dog. I continued in this manner for about five minutes, at which time I removed it from the jars, and placed it on the table. *It was alive.* In a quarter of an hour it appeared to be perfectly recovered. The other two dogs (which were not allowed to get cold during the whole of the experiment) were now examined; no motion whatever could be perceived. I tried the effect of galvanism on one of these; I was successful. In one hour after this I operated on the other dog also; but 'twas in vain—there was no vigour remaining in the vital powers; life had fled.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

SIR,—What is required at the present moment is, the formation of a company possessed of sufficient capital to enable them to enter into arrangements upon some mutual principle, with existing and new telegraph companies, to ensure, without doubt, the best materials being used, the best mechanical constructions being applied, and the greatest care being taken in all parts, of each undertaking. There are some few men yet to be found who are unfettered, and who know which are the most valuable improvements that ought to be adopted, and who would readily do so if they had the long looked-for opportunity.

The time, I think, has now arrived, to at once make such arrangements that will speedily bring into operation some of the very best inventions for the purpose, to ensure the execution of any work undertaken; and then such a company as this might very profitably employ its capital in wholly or partly maintaining the proper working of the whole or part of any line, and the risk thus incurred, and the assistance thus given, must work out the much desired object; the action of a company appears to me so simple, and yet so desirable, that I have often been surprised at the delay in establishing the same for immediately extending this very important work.

The time is now passed for concessions, and large annual payments out of the taxes of the nation, to support those who wish to study some of the difficulties connected with telegraphy; the instrument maker must confine himself to his own branch, and study, if it really requires it, to make his instruments in such a form as to properly work the cable, and not, as is generally the case, for the cable to be constructed so as to work his delicate instruments, the former must be the rule, as the expense of instruments is a trifle when compared with the cost of the cable. We can well understand some of our instrument makers wishing very hard to construct difficult and very unintelligible instruments to suit their own purposes of mystification, or, in some cases, to enlarge their own school for students, who are instructed in such a form as cannot, in any way, render any public good. Competition, in every mercantile transaction, is proved, beyond all doubt, to be of the utmost value in producing the best article, and the same applies to every branch of telegraphy, and the sooner monopoly, self-interest, and self-elected importance is abolished, the nearer we shall be to success in all the branches of this important science.—I am, sir, yours respectfully, CITIZEN.

To the Editor of THE ELECTRICIAN.

SIR.—Your correspondent "Philanthropos" upon several occasions has denounced in very eloquent, and I must say severe terms, the employment of men in the manipulation of telegraphic messages, and in business connected therewith.

As a remedy he proposes that women ought to be more generally employed in telegraph offices, and thereby obviate the most glaring delays which are at present going the round of the public journals.

In your last impression he quotes an instance of a "grave charge" of delay in the transmission of a message, and after having dilated, in his quasi eloquent manner, upon sundry subjects having little reference to the one at point, concludes in the following terms; that "if the employment of women were to become more general in telegraph offices, we might at least feel some degree of confidence, that when we enter these offices, we should meet with a becoming civility and attention, and not have to encounter the covert badinage and ill concealed insolence of beardless boys."—Poor telegraph lads, your services seem to be but appreciated to a very small extent!—however, don't be discouraged.

Your correspondent then, unconsciously, rebuts his own statement, for in the instance of delay upon which he comments, the fault lays at the door of a company who, has far as I can learn, nearly wholly employ female clerks as manipulators.

In my opinion, erroneous or not I cannot tell, females are employed

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to too great an extent, the reason of which, I presume, is to economise the expenditure and assist in swelling the dividends of the companies who employ their services, in place of calling into requisition those of male clerks. As long as girls of ages ranging from fourteen to fifteen years, and who at least ought still to be at a "Seminary for Young Ladies" are employed as telegraph clerks, errors and delays must inevitably occur, and that is as much as we can expect from them. So the sooner this intention is acted upon the better twill be for the telegraphing community, and also for telegraph companies in general, who will have little less compensation to make for errors and delays in messages.

But I must apologise for occupying so much of your valuable space, and remain, yours, most obediently. TOT HOMINES, TOT SENTENTIA.

SUBMARINE TELEGRAPHY.

To the Editor of THE ELECTRICIAN.

SIR,—Could you inform me, and also several of your readers who are interested in the matter, whether any report, embodying the experience acquired by Sir C. Bright and Mr. Latimer Clark in their endeavours to restore the Red Sea cable, has been, or is to be, published, as this might, possibly, tend to strengthen confidence in submarine telegraphy generally.—Yours, &c., OWEN ROWLAND.

Telegraphic News.

TELEGRAPHIC COMMUNICATION WITH INDIA.

WE are glad to learn that the authorities at the India Office have decided upon taking immediate steps for the completion of telegraphic communication between London and Calcutta, by continuing the land line now in existence as far as Bagdad on to the head of the Persian Gulf, and by laying a submarine cable thence to a point on the coast of Beloochistan, from which a land line is being constructed, to join the Indian system of telegraphs at Kurrachee. We understand that the work is under the direction of Colonel Stewart, C.B., R.E., who has recently returned from Persia, and whose distinguished services during the Indian mutiny are so well remembered.

From the great experience which has now been obtained in submarine telegraphy, there is every certainty that the line will be well and permanently executed in every way, and that we shall soon have the Indian news on our table every morning, instead of waiting for the fortnightly mail.

Sir Charles Bright and Mr. Latimer Clark are the engineers to the work.

COMMUNICATION BETWEEN CHINA AND EUROPE.

THE *Journal de St. Petersbourg* of the 4th inst, contains an important announcement with respect to telegraphic communication between China and this country. An order of the day, of the Director General of Ways and Public Works states, that the construction of the one of the Siberian Telegraphs which has already reached Omsk, and will in the course of 1863 be extended to Irkutsk, has, with the assistance of the post, allowed a more rapid interchange of communication between Europe and China, and that, in consequence of this, through the medium of the Minister of Foreign affairs to open communication, therefore arrangements have been carried out to enable the western powers to correspond with China *via* Russia. Despatches from the interior of the empire destined for Kiachta and Pekin, will be received for transmission at the telegraph stations at St. Petersbourg, Moscow, and Nijnia, Nov-gord.—(*Times.*)

AERIAL LINE ACROSS THE MOUTH OF THE MERSEY.

WE are informed that it has been decided to replace the submarine cable, connecting Liverpool and Birkenhead, by an aërial wire, to be thrown across the river under the superintendence, as engineer, of Mr. Lister. It is known that the cable was continually exposed to injury from the effects of ship's anchors, a source of interruption which will now be avoided. It would appear, however, that a cable laid somewhat higher up the river might answer the same purpose equally efficiently.

ON the 7th inst. the men, one hundred in number, employed under the superintendence of Mr. J. Muirhead, in the service of the Electric and International Telegraph Company, at the Telegraphic Works, Gloucester-road, visited the International Exhibition; the Directors of the Company having granted them a holiday for the purpose, and the Chairman kindly defraying the expenses.

THE transmission of messages between London and Manchester by means of the Hughes Printing Instrument, took place for the first time on Monday last, at the Office of the United Kingdom Telegraph Company, Gresham House. The correctness of transmission, and the great rapidity with which it is affected auger well for the future employment of this instrument, in which, as now constructed by Mr. Froment, several improvements have, we believe, been introduced.

Miscellanea.

SIR W. O'S. BROOKE ON THE TELEGRAPHS OF INDIA.—There is a great future before the telegraph in India. By perseverance and determination it should be made the best in the world, inasmuch as it possesses a unity of organization unattainable elsewhere, with all the resources of the empire to promote its extension and improvement. In two, or at most three years from this time, the lines should yield a clear profit, and a *uniform minimum charge for messages may then be adopted for all India.* This, with the general use of some simple cypher by habitual correspondents, will enable the telegraph to perform much of the present business of the post-office; meanwhile, we have at our disposal, at a moderate cost, an instrument of such miraculous power, that by a single message it has already saved our Indian empire, while day by day and hour by hour, it is busy in the promotion of commerce, and the furtherance of private interests of every kind. In my extended tours over all parts of India, I have seldom met a family who had not some anecdote to tell of the services the telegraph had done them. There are few Europeans in India who have not experienced a thrill of pleasure when they meet our masts and wires on the margin of every road, and know that these true tokens of science and civilization and power traverse our Indian empire to its uttermost limits. Should I see them no more, I can truly say that I shall ever continue to take the most heartfelt interest in the prosperity and improvement of the department; and feel proud and happy that it has been my lot to bring it even to its present imperfect state.

One UNFOUNDED TELEGRAPH COMPLAINT.—The following has been addressed to a contemporary:—Sir, the letter which appeared in your paper of the 27th ult,. contains such an unreasonable accusation against this company, that I shall be much obliged by your inserting our explanation. The message was duly sent out for delivery about 11.45. The only attention our messenger could get at the house was from a workman, who stated that there was no one in the house to receive the message—"the people had moved." Possibly he was wrong, as the writer states that they did not move until two; but that was all the information we could get. We therefore endeavoured to inform the sender (as is our practice) that the message could not be delivered; but, as he had merely given his address as "Westminster," and we were unable to trace him by such an address in the "Directory," we could do nothing further. I hope that your readers will see that the cause of the non-delivery of the message was not in any way the fault of this company.—I am, Sir, yours &c., CHARLES CURTOYS, Secretary and Manager.

90, *Cannon Street, October* 2.

PROGRESS OF CHEMICAL SCIENCE.—In chemistry the greatest advance which has been made during the past year is probably the formation of compounds of carbon and hydrogen by the direct union of those elements. M. Berthelot has succeeded in producing some of the simpler compounds of carbon and hydrogen by the action of carbon intensely heated by electricity or hydrogen gas; and from the simpler compounds thus formed he is able to produce, by a succession of steps, compounds more and more complex, until he bids fair to produce from inorganic sources all the compounds of carbon and hydrogen which have hitherto been only known as products of organic origin, Mr. Maxwell Simpson has also added to his former researches a step in the same direction, producing some organic products by a synthetical process. But these important researches will be fully laid before you in in the lecture on Organic Chemistry, which Dr. Odling has kindly promised for Monday evening next. Dr. Hofmann has continued his indefatigable researches on Poly-ammonias, as well as on the colouring matters produced from coal tar. Mr. Schlœsing proposes a mode of preparing chlorine by a continuous process, which may, perhaps, become important in a manufacturing point of view. In this process nitric acid is made to play the same kind of part that it does in the manufacture of sulphuric acid, the oxides of nitrogen acting together with oxides of manganese as carriers of oxygen from the atmosphere to the hydrochloric acid. The methods of dialysis announced last year by the Master of the Mint, and of spectrum analysis, are now in everybody's hands, and have already produced many interesting results.—*Professor Willis Address to the British Association.*

To Correspondents.

C. A.—1st. We shall shortly have occasion to enter upon the subject of thermo-electricity. A full account of the first experiments of Seebeck, the discoverer of this branch of electrical science, is to be found in the "Bibliotheque Universelle de Geneve," vol. XVIII., p. 353. For the experiments of Nobili, *vide* the same work, vol. XLIV., p. 225. *Vide*, also, Melloni, *La Thermochrose.* We know of no English work treating specially and fully upon this subject. 2nd. In regard to the porous jars, we must refer you to our advertising columns. If possible, call upon the manufacturer, and explain the nature of the deficiences you mention. 3rd. We cannot render the construction of the relay sufficiently clear without the aid of a "cut," which we hope shortly to give. 4th. The contact would give rise to a "derivation" or escape of electricity to earth, which, however, even when the rope was wet, would seldom be sufficient to hinder the transmission of signals.

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The Electrician.

Vol. II. No. 51.—October 24, 1862.

CONTENTS:

	PAGE		PAGE
The Chemical Theory of the Voltaic Couple	289	Sir Humphrey Davy on the Relations of the Electrical and Chemical Changes	296
Some Considerations on the Principles of Electrical Conduction, &c.	290	Prices Current of Insulating Materials	299
The Galvanic Circuit Investigated Mathematically	292	Telegraph Shares	299
Catalogue of Books and Pamphlets, &c.	293	Mr. Dodwell's Lectures	299
Notices of Books Received	295	The Sheathing of Cables	299
Abstracts of Papers read before the British Association	295	Telegraphic News	299
		Miscellanea	300

THE CHEMICAL THEORY OF THE VOLTAIC COUPLE.

(Continued from page 279.)

Polarization of Electrodes.

In our last number we reproduced the admirable paper of Professor Schönbein, in which this original and careful investigator first made known the peculiar properties of the substance to which he gave the name of *ozone*. It is now generally recognized, that ozone is merely an allotropic form of oxygen, in which the electro-negative condition of the gas is greatly intensified. The fact that several bodies, besides oxygen, are capable of assuming an analogous condition, does not appear, however, to have engaged much attention; though, as we have seen, the distinguished physicist whose name we have mentioned did not fail to notice it. "That what we call pure hydrogen," says Schönbein,* "should be capable of rendering gold and platinum electropositive, seems to me so extraordinary, and so important a fact with regard to the chemical theory of galvanism, that I cannot but ecommend it to the full attention of philosophers? What is the chemical action that can possibly take place under these circumstances?" This question, at least, can now be readily answered. The condensed hydrogen simply plays the part of a metal, electro-positive to copper, platinum, or gold; but, probably, less so than the metal zinc.† In Volta's couple, where it is produced upon the negative plate, it, therefore, reduces the initial difference of tensions by destroying the influence of this element in the polarization of the fluid; and it reduces the quantity of electricity which otherwise would traverse the circuit, not only by this diminution of tension, but, secondly, by opposing a certain resistance to the current; and thirdly, *perhaps*, by its oxidation, producing, or tending to produce, a current in the opposite direction to that which travels through the fluid from the zinc to the copper element. The latter point requires both experimental and theoretical investigation: we propose shortly to revert to it.

When, however, the positively polarized plate, in a voltaic circuit, is not opposed to a readily oxidizable metal, there is no doubt but that the condensed hydrogen becomes oxidized by effecting the decomposition of water. Thus the polarized negative element of a zinc-copper couple becomes an efficient positive when the zinc element is replaced by a plate of copper in its normal condition, and the circuit is again completed. A current in the direction, through the fluid, from the polarized to the normal metal may then be rendered evident by the galvanometer. The condensed hydrogen obviously, in this experiment, possesses the property of polarizing the electrolyte by electro-attraction of the oxygen atoms of the molecules, and of overcoming the attraction, or affinity, in these atoms for the constituent hydrogen of the fluid, which hydrogen, consequently, becomes disengaged at the surface of the normal metal. Here, it is to be observed, the effect is not counteracted by any polarizing influence exerted in the opposite direction. That *hydrogen* should, under these circumstances, possess the property of separating hydrogen from its combination with oxygen, is, certainly, a fact which claims our closest attention, and the explanation of which is calculated to throw light upon the chemical theory of voltaic action, and, indeed, upon the causes which influence chemical reactions generally.

The question first suggests itself, whether the gas adherent to the positively polarized plate is in a peculiar or allotropic condition, essentially different from that of gaseous hydrogen, and dependent upon the mode of its production. We might be inclined at once to adopt this hypothesis; nevertheless, to avoid precipitancy, let us carefully consider both the *pro* and the *contrâ*. In the first place, the condensed hydrogen, as in the case of the *nascent* gaseous bodies generally, in which the chemical affinities are greatly intensified, has not obtained the caloric which, in a latent form, gives to the gaseous bodies their elasticity and volume. In examining the polarized plate, the eye discovers no evidence of the presence of a gaseous or non-metallic body. We may wipe the plate, and thus remove all trace of moisture, and still, on re-immersion, the plate is found to be polarized. But, if we heat it below redness, or, if we plunge it in a solution of persulphate of iron, or into nitric acid, its normal condition is at once restored. If, now, we immerse it for a few moments in an atmosphere of hydrogen, the plate again becomes polarized. The effect, therefore, does not depend upon any peculiar mode in which the hydrogen might be separated during electrolysis. But the latent heat of the gas must have become dismissed; for the hydrogen is no longer in a gaseous form, but condensed upon, or rather into, the metal, and constituting, apparently, a metallic alloy. With a greater surface of metal, in small volume, we should obtain evidences of the heat which is invariably evolved in condensation.

By adding a concentrated solution of chloride of ammonium to a concentrated solution of bichloride of platinum, we obtain a yellow insoluble compound of the two salts, which, when washed with alcohol and carefully ignited, furnishes metallic platinum in a spongy condition. If we place some of this finely divided metal in a cylinder, formed by rolling up a piece of platinum foil, and direct upon it a jet of hydrogen gas from a bladder or flask, the metal speedily becomes heated to redness. The proximate cause of this phenomenon is, not merely the condensation of hydrogen, but also its combination with atmospheric oxygen. By introducing some spongy platinum into a vessel of hydrogen gas standing over the mercury trough, and containing a thermometer, we may, however, verify the assumption that gaseous hydrogen parts with its latent caloric, when it assumes the condensed form. In this condition it is capable, as we perceive in the present instance, of combining with atmospheric oxygen at ordinary temperatures: an effect which might be anticipated, since the condensed hydrogen can separate oxygen from hydrogen in water.

It is well known that, if we introduce platinum in this condition into a vessel of oxygen and hydrogen gases, mixed in suitable proportions to form water, an instantaneous explosion occurs. But, if the metal be mixed with a small portion of clay and dried by heat, it will then cause the gradual combination of the constituents of water, without explosion: an effect which appears to be due to the diminished action upon the platinum, producing a less degree of heat in this body. It has been shown by Faraday, that the combination of hydrogen with oxygen, may also be effected by means of a *plate* of platinum, providing its surface be chemically clean.

Let us now take a body resembling platinum in its electro-chemical nature, such as a strip of gold or silver, perfectly bright and clean, and immerse it in the mixed oxygen as hydrogen gases. No signs of combination will be perceived, unless we raise the temperature of the gaseous mixture considerably above that of the atmosphere. In this case water will slowly become formed.

* No. 50. p. 285.

† It has been assumed that the hydrogen upon the polarized plate is capable of reducing the metal zinc from the sulphate. It appears more probable, however, that the reduction takes place by direct electrolysis of the salt. We shall again refer to this question.

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Gold and silver are both more electro-positive than platinum; and, as we may trace their peculiar action upon the mixed gases, at least in part, to the electro-attraction for hydrogen, this action should be less powerful with these metals than with platinum. In this experiment we may observe that, whereas, the absence of latent caloric appears evidently to favour chemical combination, the *presence* of sensible caloric is productive of the same effect.‡

The presence of pounded glass, or sand, also promotes the gradual combination of the above gases; but, in this case, the temperature must be raised to nearly 660°.

From the foregoing we may, perhaps, form the conclusion that, although the term *allotropic* may be employed to denote the difference of condition between the condensed hydrogen upon the positively polarized electrode, and ordinary hydrogen; yet, this difference consists, simply, in the absence of the latent heat which is essential to gaseous bodies and which determines a repulsion of their particles for each other, and for foreign bodies. By electro-attraction, or affinity, this repulsion may be overcome, and latent caloric is then evolved; the result being a combination, of which the stability, or permanence is dependent upon the degree in which this electro-attraction is exerted, and, perhaps, also, upon the presence of a further portion of caloric in a latent form. This view receives confirmation from the fact, that in the couple of Volta, or with a zinc-platinum couple in dilute sulphuric acid, the effect of polarization of the negative element or electrode is diminished when the fluid is maintained at an elevated temperature, and increased when the temperature is lowered. In the one case the liberated hydrogen obtains with difficulty the supply of heat necessary for its evolution in a gaseous form, in the other, caloric is readily supplied. We have now to give our attention to the analogous condition assumed by the electro-negative element oxygen.

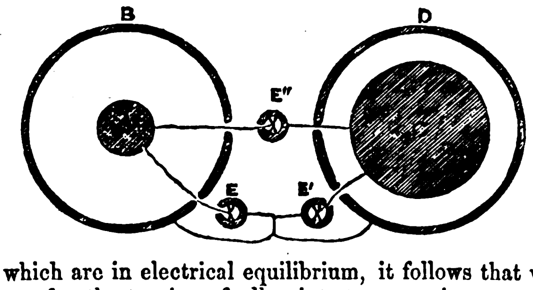
SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 279.]

As the electrical state of a point, surface, or conductor, is only relative to that of some other conductor—since it cannot exist without its equal and opposite state—tension, as has been shown, exists always between two conductors, points, or surfaces. I have always, hitherto, specified the points, or conductors, between which the tension exists. Since, however, it has been shown, that the tension between any two points is equal to the difference of tension between those points, and any third given point, or between those points and any two

Fig. 94.



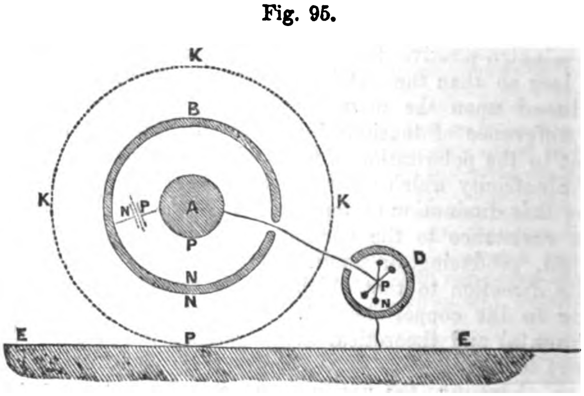
points which are in electrical equilibrium, it follows that we may agree to refer the tension of all points to one point, or to any of several points, which are in equilibrium. This being understood, at once simplifies the description of any electrical state or problem. We might for this purpose, in any problem of electrostatics take any conductor in the problem as this conductor of reference.

Thus, if (in fig. 94) it be understood that we took A as one conductor of reference; then if A be charged positively, we should speak of the tension of A as zero, and B as having a negative tension, and C would also have a negative tension. In the same way, in figure 95, if it be understood that we refer the state of all the conductors to A, then, if A is charged positively from one pole of a source, having its negative pole connected to B, then B would have a negative tension, and the earth a negative tension. If B be taken as the conductor of reference, then if the electrometer D existed, as shown in the figure, the earth would have a positive tension; but if the electrometer D did not exist, and the shell B entirely envelopes A, the earth would have no tension, *i. e.*, it would have no tension to B.

This mode, however, would be open to two objections: in the first place, we should have always to specify the conductor which we take as our datum, and, in the second, it could only be employed in cases of electro-statics, that is, in speaking of the electrical state when equilibrium had been arrived at between all points in any one conductor, or series of conductors, in conductive connection. For, if we had cases of conduction to deal with, the conductor fixed on as a datum, might have at some period of the problem a tension between two of its points, and, consequently, the difference between the tension existing between other conductors, A and B, and any points, D and C, in this conductor of reference would no longer represent the tension existing between the conductors A and B themselves; for the points, D and C, are not in equilibrium.

If we take the earth as the conductor of reference, then not only will this be a conductor which can be referred to as an element of every problem, and consequently can be agreed on as the general point of reference in all problems; but since we

Fig. 95.



cannot, by any artificial means, produce any sensible tension between two points in the earth, by virtue of its practically unlimited section as a conductor, the tension of any conductor, or any point in a conductor, to any other point, is always exactly equal to the difference between the tension of those points to any point in the earth.*

Thus, if, in fig. 94, A is charged positively by a source having its negative pole connected to B, then we should, if we take the earth as our datum, say that A had a positive tension, and if B is connected to the earth, we should say that it had no tension, or that its tension was zero. If C is uncharged, then, whilst the electrometer E′ is connected, as shewn in the figure, we should say that C had a positive tension. The electrometer E would measure the tension of A. That at E′ would measure the tension

* We might here refer to some apparently anomalous chemical reactions which are, perhaps, to be explained by a reference to the present subject matter. When the vapour of water is brought into contact with iron at a red heat, it is decomposed, and a mixture of the oxide of iron is obtained, with the evolution of hydrogen. If hydrogen be now passed over the iron oxide at a red heat, the metal becomes reduced with the formation of water. We are here reminded of the phenomenon which occurs when a voltaic circuit is formed with the positively polarized element of a couple. By contact with oxide of iron, which, like platinum, is almost intermediate between electro-positive and electro-negative bodies, the hydrogen may assume a peculiar condition, in which its affinity for oxygen, which, under ordinary circumstances, is overcome by the metal iron, is greatly increased, the free caloric also aiding the reaction.

* All changes in the electric state of the earth at different parts by any natural causes, and which give rise to what are termed "earth currents," are here disregarded.

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of C, and that at E″ would measure the difference of the tensions of A and C, or the tension existing between A and C.

In the case shown in fig. 95, if A is charged positively from one pole of a source, having its other pole connected to the insulated shell B, then we should say A had a positive tension. But if the electrometer D did not exist in the system, and the shell B entirely enveloped A, we should say B would have no tension; since an electrometer connected between B and the earth would give no indication. If A could now be taken out of the shell B, without touching the latter, B would immediately have a negative tension. And, in the same way, if, after removing A from within B, we connected up an electrometer between A and B we should measure the differences of tension of A and B, that is, the difference between each of their tensions to the earth.

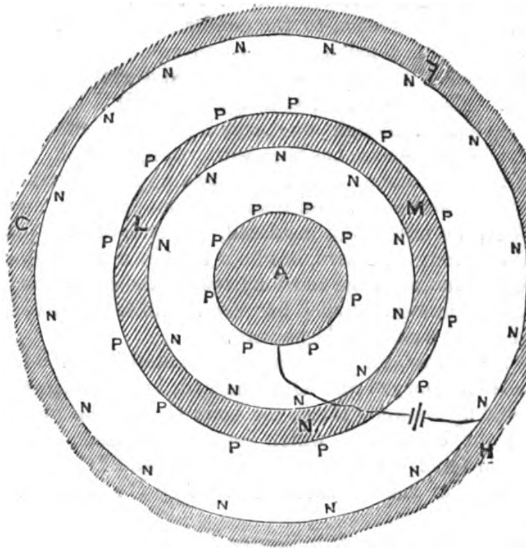
In all these cases it will be seen that the word tension is applied in a similar sense to that in which Professor Thompson (in the quotation I have given from his specification of an electrometer) applies the word "potential."*

The tests specified in this quotation for measuring the "difference of potential" between two points, would, in fact, also measure the "tension" between those points; and if applied between any point A and the earth, would measure the tension existing between that point and the earth; and if it be understood that we refer the state of every point to the earth, then it would measure what, as I have shown, may for brevity be termed simply the tension of that point, implying thereby the tension existing between that point and any and every point in the earth. And if, therefore, we apply the test between two points, having each a certain tension to the earth, then we should be measuring the tension existing between those points, and consequently the *difference* between the tension of each and the earth, or simply the difference of tension between those points.

It appears, therefore, that whatever may be the correct definition of the term "potential," as used in mathematical analysis, the two terms "tension" and "potential," when taken in the sense employed in descriptions of electrical problems, really imply the same thing viewed in two slightly different lights. Thus, if a body A is charged positively from a source having its negative pole to earth; then it would be said, according to Professor Thomson, that the potential of the earth is zero, and that the body A has a certain positive "potential." According to the view that I have set forth, equal quantities of opposite electricity are generated, and thus the body is positively, and the earth negatively, charged with equal quantities; and therefore there exists a certain tension between them. The body referred to the earth has a certain positive tension; the earth referred to the body has an equal negative tension. We adopt the former mode of reference because we cannot by any artificial means create any sensible tension between any two points of the earth, whereas we can between two points of the same conductor. But, although it is convenient to assign to the earth, as a datum, constantly a neutral or zero state of tension or potential, there appears to me, in this mode of dealing with the subject, a danger of misinterpreting the action which takes place.

If we consider that an uncharged or neutral body is a body, the sum of whose electrical states is zero, then it will be seen that in some cases this is the state of the earth, whilst in others it is that of a conductor to which we should, in the above phraseology, assign a certain positive or negative quantity as its potential or tension. To take an example, suppose a source having one pole, say the negative, connected to a surface, C F H (fig. 13), in connection with the earth, and the other connected to a conductor A, and let the conductor be surrounded by a metallic shell, L M N, insulated from the earth and from the conductor. Now, in this system, the shell, L M N, would be really the only uncharged body, for it would be simply polarised; the earth would receive a certain negative quantity, and the conductor, A, a certain positive quantity; yet, according to the phraseology I

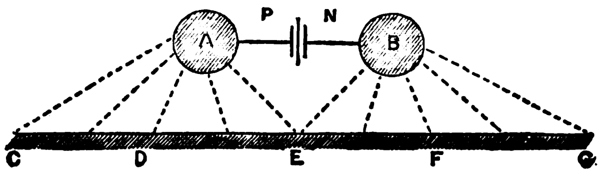
Fig. 13.



allude to, and the tests for potential and tension, the potential of the earth, although it has received electricity, would be zero, the shell, although it has received no electricity, would have a positive potential, and the conductor A would have a still greater positive potential.

If the source has each of its poles connected to conductors insulated from the earth, as in fig. 37, then the earth would be

Fig. 37.



the unchanged body, and if one of the conductors was not contained in the other, the earth would, if the conductors were near the earth, have one portion negative and another portion equally positive. In this case the earth may be said to be the polarized body, although the degree to which this would take place would depend on the distance between the bodies themselves, and their distance from the earth, and also on the degree in which induction takes place in curved lines.

Thus it will be seen there is, as a rule, no connection between the absolute charge (or sum of all the positive and negative quantities of electricity contained on a conductor) and its tension or potential, for, in some cases, the absolute quantity of electricity imparted to the earth is zero, and in others it is a certain definite positive, or negative quantity, yet, in all cases, we take it as our zero point when speaking of tension.

The connection between quantity and tension is to be found in the quantity on any surface, and the inductive resistance separating that surface from the opposite surface on which the opposite state exists (and is expressed by $T = R\ Q$), but has not necessarily any connection with the sum of the different electric states on the conductor.

Thus, in the figure 13 the quantity imparted to the earth is a certain negative quantity, equal and opposite to that on the conductor A, yet we should call the tension of the earth and the surface C H F zero. The shell L M N would have equal quantities of opposite electricity on its interior and exterior sur-

* The word "Potential" appears to have its origin in a purely mathematical expression, which Green was one of the first, if not the first, to employ, and which he terms, throughout his essay, the "potential function." This appears to be the "function which represents the sum of all the electrical particles acting on a given point, divided by their respective distances from this point."

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face, and, consequently, its absolute charge would be zero. Yet referred to the surface C H F, or any point in connection with that surface as our zero or datum, this shell has a positive tension, and an electrometer connected up between the two would be affected, and measure that tension. And in the same way the shell has a negative tension to the conductor A, and the conductor A has a positive tension to the earth equal to the difference of these tensions of the earth to the shell, and of the conductor A to the shell. Thus the earth, although charged, is taken as zero, whilst the shell, although uncharged, has a certain *positive tension*. If, after the source has been withdrawn, the shell, L M N, is connected to the surface, C H E, the two opposite quantities on their proximate surfaces would neutralize one another, and if the shell, L M N, be now again insulated, the sum of the quantities on it would no longer be zero, but be a certain negative quantity; yet, this would not alter the tension between the conductor A and the shell, and, although the shell has now a definite negative charge, its tension to the earth would be zero.

In the same way, in the case represented in fig. 94, where we supposed A charged and C uncharged, but the electrometer E″ connected up between them, the body C, and the armature of E″ formed one conductor, which became polarized; and thus C had a certain tension to the outer shells B and D, although the absolute charge of this conductor, formed by C and the armature of E″, was nil.

In the cases represented in figures 14, 15, and 37, if we suppose the surrounding surfaces connected to earth, then the earth is really the uncharged body, for the sum of its electric states will be, in each of these cases, zero.

Although, therefore, for convenience, we make the tension or potential of the earth our zero point or datum, we should be careful not to confound this with any idea that this zero state is the result of the electricity imparted to the earth expanding into its mass, or over its surface, and thus becoming insensibly small, an impression which is, as I have shown in the first chapter, conveyed in some books. As I have already shown, if a conductor is charged in an insulated room, from one pole of a source having its other pole connected to the room, nothing would be altered in any way by connecting the room to the earth. The tension exists simply between the conductor and the room, since tension, as I have shown, simply implies the proportionate departure from electrical equilibrium between two points, and the quantities generated are equal and opposite. If the room is connected to the earth the two equal quantities do not alter their distribution in the least, and the tension exists between them precisely as before.

We might take the conductor as our zero point, and assign to the room a negative tension; we take the room as our zero point, and thus the conductor has a positive tension.

(*To be continued.*)

THE GALVANIC CIRCUIT INVESTIGATED MATHEMATICALLY.

BY DR. G. S. OHM.

[Continued from p. 280.]

FROM the equation determining the force of the current in a galvanic circuit in conjunction with the one previously found, by which the electric force at each place of the circuit is given, may be deduced with ease and certainty all the phenomena belonging to the galvanic circuit. The former I had already some time ago derived from manifoldly varied experiments* with an apparatus which allows of an accuracy and certainty of measurement not suspected in this department; the latter expresses all the observations pertaining to it, which already exist in great number, with the greatest fidelity, which also continues where the equation leads to results no longer comprised in the circle of previously published experiments. Both proceed uninterruptedly, hand in hand with nature, as I now hope to demonstrate by a short statement of their consequences; at the same time I consider it necessary to observe, that both equations refer to all possible galvanic circuits whose state is permanent, consequently they comprise the voltaic combination as a particular case, so that the theory of the pile needs no separate comment. In order to be distinct, I shall constantly, instead of employing the equation $u = \frac{A}{L}y - O + c$, only take the third figure, and therefore will merely remark here, once for all, that all the consequences drawn from it hold generally.

In the next place, the circumstance that the separation of the electricity, diffusing itself over the galvanic circuit, maintains at the different places a permanent and unchangeable gradation, although the force of the electricity is variable at one and the same place, deserves a closer inspection. This is the reason of that magic mutability of the phenomena which admits of our predetermining at pleasure the action of a given place of the galvanic circuit on the electrometer, and enables us to produce it instantly. To explain this peculiarity, I will return to figure 3. Since the figure of separation F G H I K L, is always wholly determined from the nature of any circuit; but its position with respect to the circuit A D, as was seen, is fixed by no inherent cause, but can assume any change produced by a movement common to all its points in the direction of the ordinates, the electrical condition of each point of the circuit expressed by the mutual position of the two lines, may be varied constantly, and at will, by external influences. When, for example, A D is at any time the position representing the actual state of the circuit, so that, therefore, the ordinate S Y″ expresses by its length the force of the electricity at the place of the circuit to which that ordinate belongs, then the electrical force corresponding to the point A, at the same time will be represented by the line A F. If now the point A be touched abductively, and thus be entirely deprived of all its force, the line A D will be brought into the position F M, and the force previously existing in the point S will be expressed by the length X″ Y″; this force, therefore, has suddenly undergone a change, corresponding to the length S X″. The same change would have occurred if the circuit had been touched abductively at the point Z, because the ordinate Z W is equal to that of A F. If the circuit were touched at the place where the two parts A B and B C join, but so that the contact was made within the part B C, we should have to imagine A D advanced to N O; the electrical force at the point S would in this case be increased to the force indicated by T Y″. But if the contact took place, still at the same point, viz. where the parts A B and B C touch each other, but within the part A B, the line A D would be moved to P Q, and the force belonging to the point S would sink to the negative force expressed by U Y″. If, lastly, the pile had been touched abductively at the point D, we should have prescribed for the line A D the position R L, and the electrical force at the point S would have assumed the negative force indicated by V Y″. The law of these changes is obvious, and may be expressed generally thus: each place of a galvanic circuit undergoes mediately, in regard to its outwardly acting electrical force, the same change which is produced immediately at any other place of the circuit by external influences.

Since each place of a galvanic circuit undergoes, of itself, the same change to which a single place was compelled, the change in the quantity of electricity, extending over the whole circuit, is proportional, on the one hand, to the sum of all the places, *i. e.* to the space over which the electricity is diffused in the circuit, and moreover, to the change in the electric force produced at one of these places. From this simple law result the following distinct phenomena. If we call r the space over which the electricity is diffused in the galvanic circuit, and imagine this circuit touched at any one place by a non-conducting body, and designate by u the electric force at this place before contact, by u that after contact, the change produced in the force at this place is $u_1 - u$; consequently the change of the whole quantity of electricity in the circuit is $(u_1 - u)\, r$. If, now, we suppose that the electricity in the touched body is diffused over the space R, and is at all places of equal strength, and, at the same time, that at the place of contact itself the circuit and the body possess the same electric force, viz. u, it is evident u R will be the quantity of electricity imparted to the body, and

$$(u_1 - u)\, r = u\, \text{R},$$

whence we obtain

$$u = \frac{u_1 r}{r + \text{R}}.$$

The intensity of the electricity received by the body will, therefore, be the more nearly equal to that which the circuit possessed at the place of contact before being touched, the smaller R is with respect to r; it will amount to the half when $\text{R} = r$, and become weaker, as R becomes greater in comparison with r. Since these changes are merely dependent on the relative magnitude of the spaces r and R, and not at all on the qualitative nature of the circuit, they are merely determined by the dimensions of the circuit, nay, even by foreign masses brought into conducting connection with the circuit. If we connect this fact with the theory of the condenser, we arrive at an explanation of all the relations of the galvanic circuit to the condensor, noticed by Jäger,* which is perfectly surprising. I content myself with regard to this point to refer to the memoir itself, to give room here for the insertion of some new peculiarities of the galvanic circuit.

The mode of separation of the electricity, within a homogeneous part of the circuit, is determined by the magnitudes of the dips of the lines

* Schweigger's *Jahrbuch*, 1826, part 2.

* Gilbert's *Annalen*, vol. xiii.

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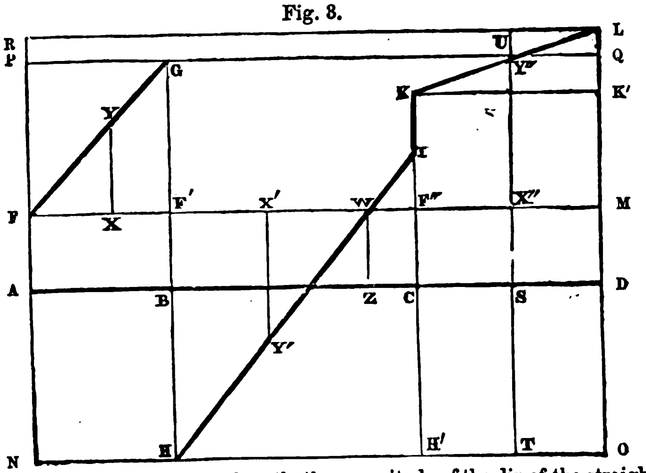
F G, H I, K L (fig. 8), and there again by the magnitude of the ratios $\frac{GF'}{AB}, \frac{IH'}{BC}, \frac{LK'}{CD}$. But, as was already shown,

$$GF' = \frac{A}{L}.\lambda, \quad IH' = \frac{A}{L}.\lambda', \quad LK' = \frac{A}{L}.\lambda'';$$

hence it may be seen, without much trouble, that the magnitude of the dip of the line corresponding to any part of the circuit, and representing the separation of the electricity, is obtained by multiplying the value $\frac{A}{L}$ by the ratio of the reduced to the actual length of the same part. If, therefore (λ), represent the reduced length of any homogeneous part of

Fig. 8.



the circuit and (l) its actual length, the magnitude of the dip of the straight line belonging to this part, and representing the separation of the electricity, is

$$\frac{A}{L} \cdot \frac{(\lambda)}{(l)},$$

which expression, if we designate by (κ) the conductibility, and by (ω) the section of the same part, may also be written thus:

$$\frac{A}{L} \cdot \frac{(\lambda}{(\kappa)\ (\omega)}.$$

This expression leads to a more detailed knowledge of the separation of the electricity in a galvanic circuit. For since A and L designate values which remain identical for each part of the same circuit, it is evident that the dips in the separate homogeneous parts of a circuit are to one another inversely as the products of the conductibility, and the section of the part. If, consequently, a part of the circuit surpasses all others from the circumstance, that the product of its conductibility and its section is far smaller than in the others, it will be the most adapted to reveal, by the magnitude of its dip, the differences of the electric force at its various points. If its actual length is, at the same time, not inferior to those of the other parts, its reduced length will far surpass those of the other parts; and it is easily conceived that such a relation between the various parts can be brought about, that even its reduced length may remain far greater than the sum of the reduced lengths of all the other parts. But in this case the reduced length of this one part is nearly equal to the reduced lengths of the entire circuit, so that we may substitute, without committing any great error $\frac{(l)}{(\kappa)\ (\omega)}$ for L, if (l) represent the actual length of the said part, (κ) its conductibility, and (ω) its section; but then the dip of this part changes nearly into

$$\frac{A}{(l)},$$

whence it follows that the difference of the electrical forces at the extremities of this part is nearly equal to the sum of all the tensions existing in the circuit. All the tensions seem, as it were, to tend towards this one part, causing the electrical separation to appear in it with otherwise unusual energy, when all the tensions, or, at least, the greater part in number and magnitude are of the same kind. In this way the scarcely perceptible gradation in the separation of the electricity, in a closed circuit, may be rendered distinctly evident, which, otherwise, would not be the case without a condensor, on account of the weak intensity of galvanic forces. This remarkable property of galvanic circuits, representing, as it were, their entire nature, had already been noticed long ago in various bad conducting bodies, and its origin sought for in their peculiar constitution*; I have, however, enumerated in a letter to the editor of the *Annalen der Physik*,† the conditions under which this property of the galvanic circuit may be observed, even in the best conductors, the metals; and the necessary precautions, founded on experience, by which the success of the experiment is assured, described in it, are in perfect accordance with the present considerations.

(*To be continued.*)

* Gilbert's *Annalen*, vol. viii. pp. 205, 207, and 456. Vol. x. p. 11.
† Jahrgang, 1826. Part v. p. 117.

CATALOGUE OF BOOKS AND PAMPHLETS ON ELECTRICITY, &c.

Mr. L. Clark's List (*continued*).

1747—Neale, John.—

[Directions for Gentlemen who have Electrical Machines. How to proceed in making their Experiments, Illustrated with Cuts, By John Neale, of Leadenhall Street, London, with a complete Series of Experiments with the Management of them as shown in his course—London: Printed for the Author in the year MDCCXLVII.] Price one Shilling and Sixpence—Pamphlet.

1748—Ellicott, John.

[Several essays towards discovering the Laws of Electricity communicated to the Royal Society. By John Ellicott, F.R.S. To which is prefixed, Part of a letter from the Abbé Nollet, Member of the Royal Academy of Sciences at Paris, and F.R.S., to Martin Folkes, President of the same. London: printed in the year MDCCXLVIII.] 8vo., 38 pages.

1748—Rackstrow, B.

[Miscellaneous observations, together with a collection of experiments on Electricity, with the manner of performing them. Designed to explain the nature and cause of the most remarkable Phenomena thereof; with some remarks on a pamphlet entitled, *A Sequel to the Experiments and Observations tending to illustrate the Nature and properties of Electricity.* To which is annexed A Letter, written by the Author to the Academy of Sciences at Bourdeaux, relative to the similarity of Electricity to Lightning and Thunder. By B. Rackstow. London, printed for the Author, in Fleet Street, MDCCXLVIII.] Pam.

1750—Mitchel, J.

[A treatise of Artificial Magnets; In which is shown an easy and expeditious method of making them, superior to the best Natural Ones: and also, a way of improving the natural ones, and of changing or converting their Poles. Directions are likewise given for making the Mariner's Needles in the best form, and for touching them most advantageously, &c. By J Mitchel, B.A., Fellow of *Queen's* College, Cambridge. Cambridge: Printed by S. Bentham, Printer to the University; and sold by W. and J. Mount, and T. Page, on Tower Hill: J. and P. Knapton, in Ludgate Street: C. Bathurst, in Fleet Street, London; W. Thurlbourn and J. Meerill, in Cambridge; J. Hildyard at York, and J. Fletcher, at Oxford, MDCCL.] Small 8vo., 81 pages, Plates.

1751—Mitchel, J.

[A Treatise of Artificial Magnets, in which is shown an easy and expeditious method of making them, superior to the best Natural Ones; and also a way of improving the natural ones, and of changing or converting their Poles. Directions are likewise given for making the Mariner's Needles in the best form, and for touching them most advantageously, &c. By J. Mitchel, B.A. Fellow of Queen's College, Cambridge. The second edition corrected and improved. Cambridge: printed by Joseph Bentham, printer to the University; and sold by W. and J. Mount, and T. Page on *Tower Hill*; J. and P. Knapton in *Ludgate Street;* C. Bathurst in

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Fleet Street, J. Beecroft in *Lombard Street*, London; W. Thurlbourn and T. Meerill in *Cambridge;* J. Fletcher at *Oxford;* and J. Hildyard at *York*, MDCCLI.] Pam. Small 8vo., Plates.

1751—Euler, Leonard.

[L. Euleri Opusculorum, Tomus III, Continent Novam Theoram, Magnetus ab Illustr., Academia Regia. Scient. Parisina Præmio condecoratum, A 1744. Una Cum Nonnullis. Aliis dissertationibus. Analitico Mechanicis (Leonard Euler) Berolini Sumptibus Ambr. Haude et Joh. Carol Spenceri, Biblipol: Reg. et Acad. Scient. Privil., 1751.] Small quarto, 165 pages.

1751—Ludolff.

[Memoire sur L'Electricité des barometres. par M. Ludolff le jeune. Traduit du Latin.] ? Published at Berlin in 1751.

1752—Penrose, Francis.

[A treatise on Electricity, wherein its various phenomena are accounted for, and the cause of the attraction and gravitation of solids, assigned. To which is added a short account how the electrical *effluvia* act upon the animal frame, and in what disorders the same may probably be applied with success, and in what not. By Francis Penrose, Surgeon at Bicester. Oxford, printed at the Theatre for Sackville Parker, bookseller at Oxford, and W. Owen, at Homer's Head, Temple bar, London. MDCCLII.] Pam.

1752—Freke, John.

[A treatise on the nature and property of Fire, in three essays.—I. Showing the cause of vitality and muscular motion: with many other phenomena.—II. On Electricity.—III. Shewing the mechanical cause of magnetism; and why the compass varies in the manner it does. By John Freke, Surgeon to St. Bartholomew's Hospital, London, and F.R.S. London, printed for W. Innys, and J. Richardson, in Paternoster Row. MDCCLII.] 8vo.

1752—Wilson, Benjamin.

[A Treatise on Electricity. The second edition. By Benjamin Wilson, F.R.S. London, printed and sold by C. Davis, in Holbourn, and R. Dodsley, in Pall mall. MDCCLII.] 8vo., plates.

1753—Penrose, Francis.

[An essay on magnetism, or an endeavour to explain the various properties and effects of the Loadstone; together with the causes of the same. By Francis Penrose, Surgeon at Bicester, Oxfordshire. Oxford, printed at the Theatre, for Sackville Parker, Bookseller at Oxford, and W. Owen, at Homer's Head, Temple Bar, London. MDCCLIII.] Pam. small 8vo.

1758—Knight, Dr.—

[A collection of some papers formerly published in the Philosophical Transactions relating to the use of Dr. Knight's Magnetical Bars, with some notes and additions.—London: printed in the year 1758.] Pam., small 8vo.

1. Contains an extract of the Minutes of the Royal Society of February 19, 1746.

2. An account of some new improvements in Artificial Magnets, communicated to the Royal Society by Conin Knight, N.B.,F.R.S., June 4, 1847.

3. Some further experiments relating to the General Phænomena of Magnetism, by the same. Read December 17, 1747.

4. A method of making the large Magnetical Bars, described in the above minutes, of more extensive use.

5. A letter from Captain John Waddel to Mr. Napthali Franks Merchant, concerning the effects of lightning in destroying the polarity of a mariner's compass.

6. An account of the Mariner's Compass that was struck with lightning and shown at the last meeting of the Royal Society; with some further particulars relating to that accident. Communicated by Conin Knight, N.B., F.R.S.

1759—Aepino, F.V.T.

[Tentamen Theoriae Electricilates et Magnetismi Accedunt Dissatationes duae quarum prior phaenomenom quoddorm Electricum altra Magneticum explicat Auctore, F.V.T. Aepino Acad. Scient: Imper. Petropolitomae Regiae Berolinensis et Elictor Mogunt Erford Membro. Instar Supplementi Commentar Acad: Imper: Petropolitanae Petropoli Typis Academiae Scientiarum, MDCCLIX.]

1759—Scarella, Joanne Baptista.—

[De Magnete. Libri Quatuor. In duos tomos distributi. Auctore Ivanne Baptista Scarella clerico regulari. Brexia anno MDCCLIX. Excudebat Ivannis — Maria Rissardi Superiorum permissu.] 4to., 2 vols.

1760—Hoadly & Wilson.—

[Observations on a series of Electrical Experiments. By Dr. Hoadly and Mr. Wilson, Fellows of the Royal Society. The Second Edition, with alterations and the addition of some subjects, letters, and explanatory notes. By B. Wilson.—London: printed for T. Payne, next the Mews-gate, in Castle-street, near St. Martin's Church. MDCCLIX.] 8vo.

1761—Croker, Rev. Temple Henry.—

[Experimental Magnetism; or, The Truth of Mr. Mason's Discoveries in that branch of Natural Philosophy, that there can be no such thing in nature as an Internal Central Loadstone, proved and ascertained. By the Rev. Temple Henry Croker, A.M., of Christ Church, Oxon.: Reader of the Temple Church, and Chaplain to the Earl of Hillsborough.—London: printed for J. Coote, at the King's Arms, in Pater Noster-Row. 1761.] Pam., 8vo., plates.

1766—Poncellet, M. l'Abbè.—

[La Nature dans la Information du Tonnerre et la reproduction des etres vivants. Pour servir d' introduction aux vrais principes de l' Agriculture. Par M. l' Abbè Poncellet, Premier Partie. A Paris P. G. Le Mercier, Imprimeur Libraires rue Saint Jacque, au Levre d'or. Chez Saillant Letraire rue Saint Jean de Beauvais vis-a-vis le College. Avec Approbation. Privilege du Roi, M,DCC,LXVI.] Small 8vo., 150 pages. Illustrated.

1766—Lovett, R.—

[Philosophical Essays, in three parts, containing—I. An enquiry into the nature and properties of the Electrical Fluid, in order to explain, illustrate, and confirm the truth of Sir Isaac Newton's Doctrine of a Subtile Medium or Æther.—II. A Dissertation on the nature of fire in general, and production of heat in particular.—III. A Miscellaneous Discourse, wherein the forementioned active principle is shewn to be the only probable mechanical cause of motion, cohesion, gravity, magnetism,

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and other phænomena of nature. To which is subjoined, by way of appendix, a clear and concise account of the variation of the Magnetic, or Mariner's Compass; by which the longitude is investigated on the most simple principles. And, to render the whole more intelligible, a Glossary of terms is added. By R. Lovett, Lay Clerk of the Cathedral Church of Worcester.—Worcester: printed for the author, by R. Lewis, bookseller and printer, at the Bible and Crown, in High-street, by whom they are sold. Also, by Mr. Sandby, in Fleet-street; and J. Johnson and Co., Pater-noster Row, booksellers, in London; and by Mr. Fletcher, bookseller, in Oxford, MDCCLXVI.] 8vo., plates.

NOTICES OF BOOKS RECEIVED.

The North-Atlantic Sea-Bed: *comprising a Diary of the Voyage on Board H.M.S. Bulldog in* 1860; *and Observations on the Presence of Animal Life, and the Formation and Nature of Organic Deposits, at Great Depths in the Ocean.* By G. C. Wallich, M.D. Part I. (Van Voorst, Paternoster Row).

To many of our readers the name of Dr. Wallich is familiar as that of a distinguished authority upon a matter of considerable import in the laying of submarine cables, viz.: the nature of the sea-bed upon which the cable may be deposited. Dr. Wallich accompanied, in the capacity of naturalist, the expedition of 1860, under the command of Sir F. L. M'Clintock, for the survey of the proposed North-Atlantic telegraph route between Great Britain and America. We remember reading, with considerable interest, the small *brochure* by this gentleman, entitled "Notes on the Presence of Animal Life at vast depths of the Sea," in which the necessity for a far more careful survey of the route of a submarine cable was strongly insisted upon. In the more elaborate inquiry into deep-ocean zoology and hydrography, of which the first part is now before us, this question, upon which there is some difference of opinion, has not, up to the present point, been referred to. Several matters, however, are treated of which cannot fail to interest those who are inclined to study the conditions which may influence the permanency of cables, more especially in high latitudes. Thus, it is shown that the circumstances of a "fiord" being furnished with rocky spurs projecting into the sea at its entrance, or having a bar across its mouth, constitutes no absolute protection from icebergs to a cable laid along it. The separation, which frequently occurs, of large masses of ice from a berg, has often the effect of lowering its centre of gravity; so that, after floating without impediment over the barrier, there is a possibility of its grounding within the fiord, and thus inflicting injury upon the submerged cable. The fact of the existence of ocean currents at extreme depths, may also be cited as important in a telegraphic point of view.

In relation to the pressure of water at extreme depths, Dr. Wallich says:—"Some idea may be formed of the vastness of the pressure prevalent at great depths, from the fact (which may be readily proved by recourse to a few figures), that at the depth of a mile it amounts to 2640 lbs., or 160 atmospheres, on every square inch; whilst at 4000 fathoms, which is equivalent to about 4½ miles, it amounts to 750 atmospheres; and water, which ranks among the least compressible of all known compounds, would be compressed, at a depth of 20 miles, to 1-20th of its original volume." In regard to the latter point we are referred to Mr. Somerville's "Physical Geography;" but, with all deference to so high an authority, we may be permitted, in the absence of experimental proof, to doubt whether water, and indeed most fluid and solid bodies, are susceptible, under any amount of pressure, of becoming condensed beyond a very limited and finite extent. The existence at great depths of conditions under which a ship's anchor—to say nothing of a telegraphic cable, would cease to sink, or, what is more in accordance with the assumption, become compressed to the most slender dimensions, appears to be founded upon purely gratuitous data, and to be in opposition, not only to experimental results, so far as these have been obtained, but to the most obvious deductions from our actual experience.

The work, which is very creditably got up by the publishers, is accompanied with a map, showing the soundings taken on board H.M.S. *Bulldog*, and with numerous illustrations of marine organisms.

Air and Water; Their Impurities and Purification. By H. B. Condy. J. W. Davies: Princes Street, Leicester Square.

Mr. Condy, besides being the patentee of the alkaline permanganates applied as disinfectants, is also a chemist of no mean ability; and, in conjunction with a medical friend, has produced a little work, which is of interest both in a chemical and medical point of view. We have, on one or two occasions, referred to the valuable properties of these oxidising agents, in removing from the atmosphere, from water, and other bodies which may have become contaminated with the products of organic decomposition, every trace of these substances, the action of which, upon the animal system, has been explained by Liebig, as being due to the production of a peculiar condition of putrefactive fermentation in the blood. By the action of "Condy's Disinfectant," the morbific products of decay, compounded principally of carbon and hydrogen, are transformed, by oxidation, into carbonic acid and water, and, instead of being counteracted or neutralised for a period, are thus absolutely destroyed. We cannot but hope, therefore, that Mr. Condy will obtain ample success in introducing into general use the powerful and innocuous purifiers which bear his name, as this success will be attended with a great sanitary benefit to the public, in the application of a discovery of science, which, otherwise, might remain ignored in practice.

Mr. Condy gives the following brief account of his discovery of the application of the permanganates for the removal of organic impurities in water:—

"The detection of organic matter in water had long presented serious difficulties to chemists, who were obliged to have recourse to very tedious methods, based on the estimation of the amount of nitrogen and carbon contained in the deposit formed by the evaporation of the water submitted to examination. Having for many years been in the habit of using the alkaline permanganates for the removal of organic impurities from certain liquid substances, which, as a manufacturing chemist, I was engaged in making, I had my attention early directed to the part which those salts were capable of performing in the purification of water. After satisfying myself that the action of those substances could with certainty be relied on for the detection and practical estimation of varying quantities of organic matter, in the year 1856, I communicated my method to several of our leading chemists, and, among others, to Professor Hofmann and Dr. R. D. Thomson, who verified my experiments, and reported favourably of the advantages of my method.

"Its superiority has been recognized by the scientific authorities of the Government department of science and art, and the application of the alkaline permanganates to the testing of water, specially pointed out in the printed papers for popular instruction at the South Kensington Museum.

"But the action of the permanganates is not limited merely to the testing of water for organic impurities; the properties possessed by those substances, of rapidly decomposing organic matter, and making manifest to the eye their effects, render them admirably suited to the purification of water employed for drinking, cooking, and general domestic purposes. Composed of oxygen in combination with manganese, the mildest and most wholesome of the metals, and one or other of the alkalies, the alkaline permanganates can hardly be supposed capable of proving injurious, even when, from haste or carelessness, a trace of them in solution, or a minute portion of binoxide of manganese in suspension may remain in the water treated: for it has recently been shown that manganese is one of the normal constituents of the blood, and that in some of the very healthiest races of men, such as the Scotch, who are fed to a great extent on oats, a cereal which contains that metal, it is always present in the body."

ABSTRACTS OF PAPERS READ BEFORE THE BRITISH ASSOCIATION.

I. ON THERMO-ELECTRIC CURRENTS IN CIRCUITS OF ONE METAL. BY MR. F. JENKIN.

Mr. Jenkin first gave a short description of the electrical currents to which he had drawn the attention of the Association at their previous meeting*, as due to loose contacts between two unequally heated wires of one metal. Experiments were then described with loose contacts between wires of two dissimilar metals. The great intensity of the currents so obtained, compared with the ordinary thermo-electric currents from metallic contact between the two metals, was pointed out; and it was shown that an analysis of the results proved, beyond doubt, that the currents were of the same nature as those produced by unequally-heated metals placed in an electrolyte; the thin films of melted oxides of copper and iron constitute this electrolyte with unequally-heated junctions at the surface of the two wires. This theory requires that the oxide of copper should be considered far more positive than iron; and the oxide of iron far more negative than copper. Direct experiments with oxides of iron and copper between platinum wires confirmed this conclusion. It was, however, still con-

* *Vide* p 15. Vol 1.

sidered doubtful how far electrolytes could be included in a true thermo-electric scale. It was stated that Sangoni had, in 1853, anticipated some of these results. A suggestion was then made that the current observed by Magnus and others at the first metallic contact of unequally-heated wires of one metal, may by due to the fact that the electrical qualities of a perfectly homogeneous metal does not depend solely on its temper and temperature, as has been hitherto supposed, but to some extent on the time during which it has been maintained at that temperature; a fact proved, as regards electrical resistance, by Mr. Mathiessen. In support of this view, it was stated that the currents obtained from these metallic contacts are not instantaneous, as generally supposed, but continue for, at least, five minutes after contact has been made, gradually diminishing from a maximum to zero.

II. ON THE LUMINOSITY OF PHOSPHORUS. BY DR. MOFFAT.

If a piece of phosphorus be put under a bell glass and observed from time to time, it will be found at times luminous, and at others non-luminous. When it is luminous, a stream of vapour rises from it, which sometimes terminates in an inverted cone of rings, similar to those given off by phosphoretted hydrogen; and at others it forms a beautiful curve, with a descending tint equal in length to the ascending one. The vapour is attracted by a magnet; it is also attracted by heat, but it is repelled by cold. It renders steel needles magnetic, and it is perceived only when the phosphorus is luminous. Results deduced from daily observations of the phosphorus in connection with the readings of the barometer, the temperature and degree of humidity of the air, with directions of the wind, for a period of eighteen months, show that periods of luminosity of phosphorus and non-luminosity occur under opposite conditions of the atmosphere; the former being peculiar to the equatorial, while the latter is peculiar to the polar current. By the catalytic action of phosphorus on atmospheric air, a gaseous body (superoxide of hydrogen) is formed, which is analogous to, if not the same as, atmospheric ozone, and it can be detected by the same tests. The author has found, by his usual tests, that *phosphoric* ozone is developed only when the phosphorus is luminous. Periods of luminosity and periods of atmospheric ozone take place under similar atmospheric conditions, and the conditions of non-luminous periods and periods of non-atmospheric ozone are the same. From the author's observations in connection with this matter, which extend over several years, it appears that 99 per cent. of luminous periods, and 91 per cent. of ozone periods commence with decreasing readings of the barometer, and other conditions of the equatorial current; and that 94 per cent. and 66 per cent. terminate with increasing readings and the conditions of the polar current. Luminous periods commence, and luminosity increases in brilliancy, on the approach of storms and gales, and ozone periods commence, and it increases in quantity, under similar conditions. There is, it would appear also from these observations, an intimate connection between the approach of storms, the commencement of luminous and ozone periods, and disorders of the nervous, muscular, and vascular systems. Here the author gave the dates of many storms and gales, and the occurrence of diseases of the above class, showing their coincidence; and in corroboration of what he had stated, he mentioned the fact, that there was a concurrence in the issuing of Admiral FitzRoy's cautionary telegrams and these diseases. He also stated, that he views the part performed by ozone in the atmosphere as being similar to that performed by protein in the blood; the latter giving oxygen for the disorganization of worn-out tissues in the animal economy,—the former giving oxygen to the products of decomposition and putrefaction, and rendering them innocuous or salutary compounds. With these views he has used phosphorus as a disinfectant; and from the results he has obtained, he believes that by using ozone, artificially formed by the action of phosphorus, in localities tainted with the products of putrefaction, just in sufficient quantity to tinge the usual test-paper, all diseases of the pythogenic class would be prevented. Although the data are too few to theorize upon, Dr. Moffat hoped that he would be excused for pushing the matter beyond a simple statement of facts and observations, as many facts had been observed in nature which strongly corroborated all he had advanced. Ozone, he observed, is, in all probability, formed wherever there is a phosphorescence; and this is by no means an uncommon phenomenon. It is seen in life and in death, in the animal and vegetable kingdoms, and in the mineral kingdom. Here many instances of phosphorescent bodies were enumerated, among which the night-shining Neries was named, as becoming particularly brilliant with a direction of wind from points of the compass between east and south; and the fact that the sea becomes luminous on the approach of storms, by marine animals floating on its surface, was noticed. Many phosphorescent minerals were named; the fluor spar being particularly pointed out as being not only phosphorescent on slight increase of temperature, but as giving off ozone. The author concluded by observing, that it is not improbable that atmospheric ozone is formed by the phosphorescence of these and similar bodies, and pointed to the absence of ozone and weak magnetic action during cholera periods, which are periods of non-luminosity, and to the disappearance of cholera with the setting in of the equatorial current, which is ozoniferous, and favourable to luminosity. The aurora, the author thinks, may yet be proved to be a display of luminosity.

III. ON A PHOTOLITHOGRAPHIC PROCESS ADOPTED BY THE GOVERNMENT OF VICTORIA FOR THE PUBLICATION OF MAPS. BY MR. J. W. OSBORNE.

The process was first adopted by the Government in Sept., 1859, and has since been extensively used, and many hundreds of maps and plans produced by its means. The object of the process was the reproduction of drawings and engravings in black and white, without the gradations known as half-tone. For this purpose a perfect negative must first be obtained by the ordinary methods. From this a photographic positive is printed by the agency of light on paper which has received a coating of a mixture of gelatine, albumen, and bicromate of potash. The action on this compound is to render such parts as are subjected to its action insoluble in water. The positive so obtained is covered entirely by lithographic transfer ink. This done, the paper is floated, with its inked side upwards, upon a tray of boiling water. By this process the inked is fused, the albumen is coagulated, and the gelatine, not rendered insoluble by the action of light, is softened. When these effects are completed, gentle friction with a sponge removes the ink and the gelatine from all parts of the paper, except those which form the image to be produced. The resulting picture is a positive transfer which is transferred to the stone in the usual manner employed by lithographic printers. The result is an image on stone from which any number of copies may be produced by the ordinary process of lithographic printing.

SIR HUMPHREY DAVY ON THE RELATIONS OF THE ELECTRICAL AND CHEMICAL CHANGES.

On the modes adopted for detecting the Electrical States of Bodies, and definitions of Terms.

That the statements made in the following sections may be more distinct, I shall say a few words of the modes in which the different conditions of electrical action were ascertained, and describe the manner in which I have used the terms which have been adopted in electro-chemical science.

In determining the nature of the electrical action in what may be called the close circle, or the combinations in which, according to the language used on the continent, electrical currents exist, I have employed instruments constructed upon the same principles as the galvanometer of Professor Cumming, or the multiplier of Professor Schweigger. Silver wire covered with silk, about 1-70th of an inch in diameter, was folded round a small wooden frame, so as to fill a narrow deep grove: the two extreme wires were parallel, and the convolutions as nearly as possible in the same perpendicular: a small tube containing a filament of silk was passed through the centre of the convolutions of wires, to which a delicate magnetised needle was suspended; which, when the apparatus was properly disposed, rested with its north pole between the two extremities of the wires. This instrument, which contained 60 circumvolutions of wire, was found sufficiently delicate for most purposes of experiment; but in a few instances, in which very weak electricities were to be determined, I used another apparatus, in which the same kind of wire was fastened, in concentric circles, round two portions of glass tube, in such a manner that radii from the inner circle would have passed through all the wires, and in which increased mobility was given to the system by two needles exterior to it and connected with it, placed one above, the other below the central needle, with their poles in the same directions, but opposite to those of the central needle, which was so magnetised that its directive power was neutralised by the power of the other two needles.*

To illustrate the operation of these apparatus, I shall state, that when the lower terminating wire, which was to the left, or east of the north pole, was connected with a piece of zinc, and the upper one with a piece of platinum, both being in common water, the deviation of the central needle was eight or ten degrees, the south pole turning to the east or left hand; which may be considered as indicating that the current of electricity was from the platinum to the zinc through the wire, and that the surface of the zinc in the fluid was positive with re-

* This arrangement differs from that of M. Nobili only by a duplication of effect.

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spect to the opposite surface of platinum; and in using the terms positive and negative, I beg to be understood as applying them so the metallic surfaces in contact with the fluid.

For determining weak electricities of charge, or as it is sometimes called, of tension, I used Volta's condenser connected with Bennet's electrometer, and sometimes with one constructed on the principle of Behrens, consisting of an insulated gold leaf, or what I found better, a silk filament, made conducting by inpalpable charcoal powder, to receive the charge, placed between the poles of a dry pile consisting of 400 circles of silver and gold foil, of the third of an inch in diameter, or 50 of zinc and silver of the same size, with paper intervening; the attraction of the gold leaf or the filament, either to the positive or negative pole, indicates the nature of the charge; and, as in cases of electro-chemical action there are always two corresponding opposite states, I considered the part of the system which touched the conductor as possessing the same electrical state with that exhibited by the leaf. I have never, however, put much dependence upon indications given by this instrument, unless they were confirmed by other results; having found them very uncertain, and influenced by the state of the condenser and the atmosphere.

On the Electrical and Chemical Effects exhibited by Combinations containing Single Metals and one Fluid.

I know of no class of phænomena more calculated to give just views of the nature of electro-chemical action than those presented by single metals and fluids: and as their results are, with one or two exceptions, entirely new, I shall describe them with some degree of minuteness.—When two pieces of the same polished copper, connected with the platinum wires at the multiplier, were introduced at the same time into the same solution of hydro-sulphuret of potassa, there was no action; but if they were introduced in succession, there was a distinct, and often, if the interval of time was considerable, a violent electrical effect—the piece of metal first plunged in being negative, and the other positive.

This result depends upon the circumstance of the production of a new combination, which is negative with respect to the metal; for after the formation of the sulphuret of copper, the plate of copper that has been first plunged into the solution exhibits the same negative state with respect to polished copper, whether introduced into saline solutions, or alkaline or acid menstrua. The electrical effects therefore does not depend on so simple a condition as would at first appear, and it may be, in fact, referred to the combinations containing two metallic substances and one fluid.

The gray sulphuret of copper is negative, in solutions of hydro-sulphuret, to clean copper, and the superficial coating has apparently similar electrical powers to his substance.

Copper, in the state of protoxide, is negative, not only with respect to metallic copper, but likewise with respect to the sulphuret; a circumstance which explains many similar and apparently anomalous circumstances with respect to the action of hydro-sulphuret on copper. I have often found the order which I have mentioned, of metallic copper being positive with respect to copper that had been a few seconds in solution of hydro-sulphuret, reversed in a singular and capricious way; but on investigating the cause, I have often found that the copper was tarnished; and on heating any kind of polished copper strongly, so as to produce a thin coating of oxide anywhere on its surface, it became strongly negative to copper plunged in solution of hydro-sulphuret: the same effect was produced by the action of acids.

There are some singular circumstances connected with the violent and intense chemical action of copper on solutions of hydro-sulphurets, which are worthy of being described. When a piece of copper connected with the multiplier has been for a minute in strong solution of hydro sulphuret of potassa, on introducing a piece of polished copper connected with the other wire, there is often a violent and momentary negative charge communicated to it, which sends the needle through a whole revolution: it then oscillates, and almost immediately returns, and takes the direction which indicates that the piece first plunged in is negative. This effect continues for some minutes, then becomes weaker; at last the two sides are in equilibrium, and the piece which was first plunged in now becomes positive with respect to the other. The first described of these effects seems to depend upon the discharge, by the clean copper, of the negative electricity accumulated by the contact of the plate first plunged in, before the relative states produced by the metallic contact and the regular currents occur; and the second, to the detaching or peeling off of the coat of sulphuret, which has the effect of exposing a clean surface, and which effect is probably occasioned by the oxidation of the positive side of the plate.

There are few electrical actions more intense than those produced by the operation of hydro-sulphurets on copper in these different circumstances; so much so, that I have constructed a Voltaic battery which decomposed water, by six combinations, consisting merely of thin slips of copper, of which one half had been exposed to the solution about a minute before the other half; of course the oxidating surface was on the side of the clean or latest exposed metal.

With lead, and alloys of tin and lead and iron, there are the same phænomena, but much feebler electrical action, the metallic surface; which is first introduced being the negative surface; and the principles of this kind of action are precisely the same as those of copper and hydro-sulphurets.

Zinc, platinum, and metals which have no chemical action on solutions of hydro-sulphurets, produce no phenomena of this kind; silver and palladium, which acts powerfully with these menstrua, produce very decided effects; but the compounds they form in them being positive with respect to the pure metals, the phenomena are the reverse of those offered by the more oxidable metals; the surface plunged first into the solution is the positive surface, and it retains this relation in alkaline, acid, and saline solutions presenting peculiarities dependent upon the change of surface, which I shall refer to again hereafter.

The production of electrical currents by single metals and single fluids, though most distinct in the cases I have just named, yet occurs generally whenever new substances which can adhere to the metals are produced in chemical action. Thus in acid solutions of a certain strength pieces of the same zinc, tin, iron, and copper, exhibit similar phenomena; the surface first plunged into the acid being tarnished, or retaining a slight coat of oxide, is negative to the metal plunged in afterwards, and the relation is sustained in saline or alkaline solutions. The same effect is caused by producing a coat of oxide by heat on the surface, or even by applying it artificially. The oxidated surface is negative with respect to the other.

Zinc, which dissolves in a strong solution of potassa, giving off hydrogen copiously, exhibits exactly the same phenomena in this solution; the tarnished metal, or that first introduced, being negative with respect to the other. Tin likewise in solution of potassa, having been introduced long enough to have tarnished, is strongly negative with respect to polished tin.

Even the noble metals obey the same law. Silver, that has been tarnished by the action of nitric acid, is negative to polished silver in diluted acid; and gold and platinum, that have been acted on by aqua regia, are negative in that acid to the clean metals.

The intimate connection displayed in all these cases between the chemical and electrical phenomena, becomes still more remarkable when the nature of the changes taking place in circles of this kind is considered.

Oxygen, wich may be considered as negative with respect to all the metals, and sulphur, which is negative with respect to the oxidable metals, by their combinations with metals respectively positive to them, produce compounds negative with regard to those metals. And in the chemical changes the results are such as must ultimately restore the equilibrium, hydrogen or sulphuretted hydrogen passing to the negative side, and oxygen to the positive side; so that the oxides are revived; and not only is the equilibrium restored, but the poles sometimes changed. Thus tin that has tarnished in acid, remains for some time negative in solution of alkali, but gradually as the oxide upon it is revived by the hydrogen determined to this surface, it loses its negative power; and the other surface, now tarnished by the action of the alkali, gains this power, whilst the opposite side becomes positive.

Of Electrical Combinations, consisting of Two Imperfect and One Perfect Conductor; or Two Fluids and a Metal, or Charcoal.

To understand clearly the nature of the action in this kind of electrical combination, it is necessary to consider the nature of imperfect conducting bodies, water, or saline solutions. These bodies may be regarded as having the same relations to electricities of very low intensity, that elastic fluids have to the electricities of glass, sealing-wax, or the common machine. They communicate the electrical polarities of the metals, but do not appear capable of receiving such polarities, or at least of retaining them; and the electrical equilibrium, when broken in them, seems to be rapidly restored by a new arrangement or attraction of certain of their elements. For instance, if we introduce the positive and negative poles from a very powerful voltaic battery into the extremities of a basin filled with solution of muriate of lime, and place in the circuit different wires of platinum, every wire will possess a positive and negative pole, and there will be no division of the fluid into two parts, one positive, the other negative; and when the two wires are withdrawn, they alone having been used, the electrical appearances immediately cease; and metallic wires unconnected with the battery made to occupy their places, exhibit no electrical phenomena: and in all experiments of this kind, the well known phenomena of the

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development of chlorine and oxygen and acid matter at the positive, and hydrogen, alkaline matter, &c. at the negative pole, takes place.

Acid and alkaline matters, when perfectly dry and non-conducting, become on contact negative and positive; as I have shown is the case with oxalic acid and lime; but this effect is similar to that of glass and silk, and the result is a common electricity of tension. And when acids and alkalies combine, their union being apparently the result of the same attractive powers acting on the particles which would produce their electrical relations as masses, they exhibit no phenomena of electro-motion; and such phenomena when they occur in combinations in which acids and alkalies unite, always depend upon the contact of the metal with the acid and alkaline matter, change of temperature, evaporation, &c., and never on the combination of the acid and alkali.

As a different opinion has been lately started, on high authority*, I shall give the proofs of the truth of this my early view, which appear to me of the strictest demonstrative nature.

A solution of nitre, which is a substance neutral to the contact of noble metals, was introduced into a glass cup containing a plate of platinum connected with the multiplier: pure concentrated nitric acid was placed in another cup, in which there was another plate of platinum joined to the other wire of the multiplier, and the connexion was made by a piece of asbestus wetted in a solution of nitre. At the moment of contact, the needle indicated a strong electrical action negative on the plate plunged in the acid, and which occasioned a permanent deviation of about 60°.

This arrangement was removed from the multiplier, and another substituted for it, in which strong solution of potassa occupied the place of the nitric acid, being in contact with platinum in one cup, and solution of nitre in the other, with the same communications. The deviation was now much weaker, about 10 degrees, and the platinum in the solution of potassa was positive.

The nitric acid and the solution of potassa were now connected in the arrangement by a piece of clean asbestus, moistened in a concentrated solution of nitre; the deviation of the needle was to about 65°. In this instance there was no chemical action of the fluids on each other; for they had no tendency to mix rapidly with the solution of nitre, which, being of less specific gravity than either of the other solutions, remained in the asbestus; and there was no effect beyond that of the metallic contact of the platinum with acid and alkali.

A piece of asbestus, of nearly the same size with the other, but dry, was now substituted for the moist asbestus, so that the acid and alkali combined by capillary attraction producing heat; at first, the deviation was rather less than in the former instance; but as soon as the combination was complete, the needle stood exactly at the same point, proving that no electricity was developed by the combination, any more than by the indirect communication of the acid and the alkali.

After trying the effects of the contact of fluid acid upon platinum by the arrangement with solution of nitre, and finding that oxalic acid was the acid among the powerful ones which produced the slightest deviation of the needle, or the smallest negative effect, I employed this acid and solution of potassa, exactly in the same manner as the nitric acid in the experiment just detailed; as the joint action of the acid and alkali on the platinum was only to produce a deviation of 7 or 8 degrees, it might be suspected that any electrical action produced by combination might be more easily manifested; but no such effect occurred; and whether the communication was made by combination through dry asbestus, or through asbestus wetted in a saline solution, the effect was precisely the same.

Again, the two surfaces of platinum were placed in contact with strong solutions of nitre, and the communication made between them by solution of potassa and nitric acid; there was no electrical action, though the chemical combination was intense. But when the fluids were mixed, so that a little acid touched one plate of platinum and a little alkali the other, electro-motion immediately began; and in using muriatic acid and solution of ammonia, which, being lighter than the saline solutions, very soon come in contact with the platinum, the effect commenced almost immediately, and continued for some time to increase.

Again, I placed pieces of paper coloured with litmus and turmeric, and moistened in solutions of nitre, upon two surfaces of platinum connected with the multiplier; they were covered with a stratum of porcelain clay wetted with the same solution, a stratum of clay moistened with muriatic acid was placed above on one plate, and a stratum moistened with solution of ammonia above on the other, so as to make a contact in which there should be action a large surface without direct communication with the metals. In several experiments of this kind there was no electro-motion; and whenever it was perceived, it was found that either the acid, or the alkali, or both, had penetrated through the clay, and touched the metals so as to change considerably the colour of the papers, which were placed as indications of the correctness of the experiment.

Having brought forward what appear to me decided proofs on this subject, I shall now proceed to investigate the operation of the metals and fluids in combinations containing two of the latter substances. At first I was surprised to find that platinum acted so powerfully with nitric acid, which undergoes no chemical change by contact with it, and suspecting that it might arise from the presence of minute portions of muriatic acid or muriatic salts, I took great pains to exclude these substances by washing the platinum in distilled water, not touching it with the hands, &c., but when the conditions were those of perfectly clean and pure platinum, and perfectly pure nitric acid, the phenomena were the same. Similar reasonings may be applied to solutions of potassa, soda, &c., which do not chemically alter platinum by contact, and yet render it positively electrical with respect to platinum in water or saline solutions. It must, however, be called in mind that the oxygen in nitric acid, and the metals in the alkalies, have attractions of a very decided kind for platinum; and in taking the scale of electro-negative bodies, solutions of chlorine, or nitro-muriatic acid, produce a more powerful electrical effect on platinum than nitric acid, nitric acid than muriatic, and muriatic than sulphuric.

When platinum is brought in contact with an acid, the pole touching the acid is negative, the opposite pole is positive, as I have found by the condensing electrometer; and the reverse is the case when it touches an alkali; so that the circulation of the electricity is from the metal to the alkali, and from the acid to the metal.

Rhodium iridium, and gold, act in combinations consisting of acid and alkali, on which they have no chemical effect, exactly like platinum; the surface of the metal in the solution of alkali being positive, that in the solution of the acid, negative. With silver and palladium the electricity is greater, particularly if nitric acid is used; and with charcoal and oxidisable metals, there is the same general result, the action being in general exalted in proportion as the chemical attractions are stronger, provided there are no interfering circumstances: and in combinations of this kind nitro-muriatic acid is more active than nitric, and the order is after, nitric, nitrous sulphuric, phosphoric, vegetable acids, sulphurous, prussic, sulphuretted hydrogen; and, with the alkalies, potassa, soda, baryta, ammonia, and so on.

It is always to be understood that strong or concentrated solutions of acids and alkalies are employed; for in cases where the quantity of acid or alkaline matter is very small, and the chemical action of the metals strong, there is sometimes a different order. Thus zinc and tin tarnish immediately even in a weak solution of potassa, and, so tarnished, they are negative to the same metals in weak solutions of muriatic or sulphuric acid; but in experiments of this kind it is easy to determine the true circumstances by changing the poles; the negative side, when the energies of the alkali and acid are weak, will be determined by the tarnish or coat of oxide formed.

Solutions of sulphuret act in these combinations like alkali, with circumstances depending upon the formation of new compounds, according to the law explained in the last section. In combinations, of which the elements are hydro-sulphuret and acid, the metal in the hydro-sulphuretted solution is positive, and that in the acid negative; but with alkalies, and hydro-sulphurets and zinc, and tin, the metal in the solution of alkali is positive, and that in the solution of hydro-sulphuret, negative: with silver and palladiun the opposite order occurs, and with copper there is nearly a balance of powers, or changes of power, dependent upon the circumstances detailed in the last section.

When, in electrical combinations containing one metal, water or a neutro-saline solution is in one of the cups, and alkali or acid in another, the result is usually such as might be anticipated—the side of the metal in the alkali is positive, that in the acid negative, and that in the neutro-saline solution in the opposite state. There are, however, certain neutro-saline solutions, which, when they contain oxygen or common air, act upon the more oxidable metals, and such have a power or energy of their own; thus zinc, and tin, and copper, in solution of common salt, are positive to the same metals in distilled water; and the surfaces of the same metals in weak muriatic acid are positive with respect to the surfaces in water or saline solutions. In combinations, in which weak and strong solutions of acid or of alkalies are the two fluids, both being of the same kind, the electrical action is usually feeble; but the surface in the strongest alkali is most positive, and in the acids the result usually depends upon the nature of the solution; if oxide is formed and deposited, the strongest acid is negative with respect to the diluted one.

* That of M. Becquerel.

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The chemical changes produced in combinations of this kind, are best observed in cases where the metal undergoes no change; for instance, with platinum, diluted sulphuric acid, and solution of potassa. In this combination, hydrogen soon appears on the platinum in the acid, and a very small quantity of gas, which is probably oxygen, on the platinum in contact with the alkali; and that the acid tends to circulate towards the negative surface, and the alkali towards the positive, is shown by the circumstance of the rapid neutralization of the two menstrua, though separated by asbestus moistened in distilled water.

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Fine Para	2s. 1d.	per lb.
Negro	1s. 3d.	"
Java	1s. 6d.	"

Gutta Percha

Fine	2s. 4d. to 2s. 6d.	per lb.
Genuine Mixed	1s. 9d. to 2s. 0d.	"
Ordinary Reboiled	10d.	"

Firm markets in both articles.

October 22, 1862. Wm. Kirkmann,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic, A.	100	54 to 57	——
20	Do. B 7 per cent. till 1862 .	all	19 to 21	——
20	Do. C	—	——	——
Stock	Electric Telegraph . .	100	100 to 103	——
25	Do. New	20	——	——
5	London District Telegraph .	$4\frac{3}{4}$	4 to 3 dis.	——
10	Lond. & S. Ireld. Direct Tel.	2	— pm.	——
10	Mediterranean Extension Tel.	all	3 to 4	——
10	Do. 8 per cent. pref.	all	——	——
1	Submarine Telegraph, scrip.	all	$\frac{3}{8}$ to $\frac{5}{8}$	——
1	Do. registered . . .	all	$\frac{3}{8}$ to $\frac{5}{8}$	——
10	Do. " . . .	all	4 to 6	——
2	Telegraph to India . .	1	$\frac{3}{4}$ to $\frac{1}{2}$ dis.	——
5	United Kingdom Telegraph .	3	$\frac{1}{2}$ dis. to par.	——

MR. DODWELL'S LECTURES.

The *Southport Visitor* contains a lengthy account of a lecture on the Electric Telegraph, given at the Athenæum in that town, by Mr. Robert Dodwell, under the presidency of John Fernley, Esq.

The Athenæum having been recently inaugurated by Dr. Fairbairn, and having met with marked success, arrangements were made for a series of lectures of which Mr. Dodwell's was the first.

After some observations relative to the progress of the Institution, the Chairman read an extract from the *Quarterly Review*, describing the first successful experiments with the electric telegraph, by Professor Wheatstone, as follows:—

"Late in the evening of the 25th of July, in a dingy little room near the booking-office in Euston Square, by the light of a flaring dip candle, which only illuminated the surrounding darkness, sat the inventor, with a beating pulse and a heart full of hope. In an equally small room, at the Camden Town station, where the wires terminated, sat Mr. Cooke, his co-patentee, and among others, two witnesses well known to fame, Mr. Charles Fox and Mr. Stephenson. These gentlemen listened to the first word spelt by that trembling tongue of steel, which will only cease to discourse with the extinction of man himself. Mr. Cooke, in his turn, touched the keys, and returned the answer, 'Never did I feel such a tumultuous sensation before,' said the professor, 'as when all alone in the still room I heard the needles click; and as I spelled the words, I felt all the magnitude of the invention, now proved to be practical, without cavil or dispute.'"

The Chairman continued:—The telegraph thenceforward, as far as its mechanism was concerned, went on without a check, and it is now so much improved, and is carried to every important town, so as to become almost essential to our commercial community.

The experiments were of the usual character, the lecturer confining his remarks to the double needle telegraph of Cooke and Wheatstone, and the Bell Telegraph of Sir Charles Bright.

A message was sent to Manchester, to desire the clerk there to repeat the alphabet, which was done in an incredibly short time. The state of the weather was then asked, when the reply was—"Very cold, but fine." In answer to what was the number of clerks in the office at Manchester, the reply was "six." The Manchester clerk was then asked if it were possible to work to London, when he replied, "The test-box in Market Street is filled with gas; a boy struck a match to light his pipe, and caused an explosion. The door was blown off, and floored the youthful smoker. All made safe." A message was next sent to London, asking the time, when the reply was "9.14." Was that by the Royal Exchange clock? "I can't see the Royal Exchange, but that is the time, I am certain." What weather in London? "A fine starry night." Were there any cabs about? "Yes, plenty." The London clerk was next asked if he could put them through to Paris, when he replied, "Sorry, we can't; the wires are engaged." Did he belong to the volunteers? "Not a volunteer." What was his name? "Wilson." What was his age and when going to be married? "Seventeen. Would get married when he left the telegraph service." He was asked for some piece of important news. "Had got none." How long had he been in the company's service? "Five years and a half." Being asked for some small item of news, the reply was a small despatch from the Paris Bourse, to the effect that it was firm and animated, and funds closed 30 cents higher than on the previous day. These questions and answers, carried on with such marvellous rapidity, caused much interest and amusement to the audience. The lecturer closed with a few remarks on the study of the electric telegraph in its varied forms, each branch of which was a source of continued interest and improvement.

THE SHEATHING OF CABLES.

The armour of the cable is intended as a protection against pressure, strain, and friction. We have, however, already seen that this same armour may be an enemy, as much as, if not more than, a friend; the pressure it may resist on account of its strength, but the strain which it is called upon to bear is simply caused by its own weight, and in proportion as this weight is lessened, the strain is removed. The friction again is, in a great measure, caused by the great weight, and if that weight were reduced the friction would be considerably diminished. Moreover, as the friction after paying out is principally against rocks, iron-wire is one of the worst resisting materials; for any one may, with ten minutes' manual labour, cut through, by friction against a rock, even a stout submarine iron covered cable. To cover a cable with iron-wire would appear, therefore, much like clothing the light infantry soldier in plate armour as a protection against Minié bullets. He would be encumbered thereby, and even then would not be protected.

The difficulty attending the submersion also is entirely caused by the weight of the above-mentioned armour, and vanishes in proportion to the decrease of that weight. The requisites for a good cable, therefore, appear to be as follows:—Perfect and permanent insulation; protection against friction and permanent compression; lightness; and a power by which to avoid any sudden or unusual strain. If a cable possess these qualities, paying out will be but a simple matter of care and watchfulness. No ponderous machines would be requisite; the weather might be fine or otherwise, the ship would be in no danger from her burthen, and one vessel might, if considered advisable, pay out two thousand miles of such a cable, for, being light, it need not be coiled low down in the ship, but might be placed in any part.—*Description of the Patent Elongating Tunnel Telegraph Cable*, 1858. By Capt. Drayson, R.A., and Capt. Binney, R.E.

Telegraphic News.

PRESENTATION TO AN OLD TELEGRAPHIST.

On Saturday last a deputation, consisting of Mr. William Powell, engineer of the United Kingdom Telegraph Company, and Messrs. J. Oldham, A. Esplin, H. Robinson, and J. Webb, waited upon Mr. Samuel Percy (late superintendent of the British and Magnetic Telegraph Company), at his residence at Manchester, and in the name of 57 subscribers, presented him with a handsome and valuable gold watch, bearing a suitable inscription, as a token of esteem.

Mr. Oldham made the presentation, and said that it gave him great pleasure to present Mr. Percy with a testimonial, as a token of respect which a large circle of friends and acquaintances entertained for him.

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Mr. Percy, in reply, thanked the deputation, and desired they would convey his grateful acknowledgments to the subscribers to the testimonial. Although he was no longer a telegraphist, yet after a connection of 10 years, it was impossible to avoid feeling the warmest interest in the telegraph service. And the handsome testimonial with which he had that day been presented, would constantly call to mind those old friends with whom he had been long and agreeably associated; and when in the ordinary course of events the watch passed into the possession of his son, he trusted the inscription would remind him that his father had obtained the respect of a large circle of friends, who thought him not unworthy to receive a testimonial at their hands.

With reference to the paragraph in our last issue respecting the erection of an aërial wire between Liverpool and Birkenhead, we are informed that this project has not originated with, or received the sanction of, the Mersey Docks Company, who are the owners of the present subaqueous line. The cable at present employed, which was constructed by Messrs. Silver & Co., is stated to be as perfect in its insulation as when first laid down, and with the exception of the accidental injuries from ships' anchors, which have occasionally happened, to work very satisfactory.

Bonelli's telegraph line is not yet open to the public between Liverpool and Manchester. Tenders are being sought for the extension of the wires to other parts of the country.

Miscellanea.

Charcoal, which is classed among the electro-positive bodies, possesses at ordinary temparatures but little affinity for the electro-negative oxygen; though at high temperature this affinity is very intense. Like platinum, it appears to exert an attraction for gaseous bodies, both electro-positive and electro-negative in their nature. According to the experiments of Saussure, with box-wood charcoal, the absorption of gaseous bodies is as follows:—

Ammoniacal gas	90	volumes
Muriatic acid gas	85	„
Sulphurous acid	65	„
Sulphide of hydrogen ...	55	„
Protoxide of nitrogen ...	40	„
Carbonic acid	35	„
Olefiant gas	35	„
Phosphuretted hydrogen ...	10	„
Carbonic oxide	9·42	„
Oxygen	9·25	„
Nitrogen	7·5	„
Hydrogen	1·75	„

The density of air at various altitudes is shewn in the following table:—

Miles.	Volumes.	Density.	Barometer.	
0	1	1	30	inches
2·705	2	$\frac{1}{2}$	15	„
5·41	4	$\frac{1}{4}$	7·5	„
8·115	8	$\frac{1}{8}$	3·75	„
10·82	16	$\frac{1}{16}$	1·875	„
13·525	32	$\frac{1}{32}$	0·9375	„
16·23	64	$\frac{1}{64}$	0·46875	„

It is upon the principle involved in this table that we are enabled to determine the altitude of any situation above the level of the sea. A simpler method of obtaining the height is to ascertain the diminution of atmospheric pressure by observing the temperature at which water boils. It has been found that water boils at a temperature lower by 1° for every 549½ ft. of ascent.

In aërial lines of telegraph, inannealed iron wire, and steel wire have been successfuly employed for spans of 2000 yards. No. 16 gauge wire is generally used for long *spans*.

Iron wires for telegraph service are specified as follows: the best and most expensive being placed first:—

Best charcoal galvanized iron wire.
Best, best, best galvanized annealed iron wire.
Best, best galvanized annealed iron wire.
Best galvanized annealed iron wire.

The process of annealing lessens the strength of the iron, as also the "galvanising" process, or coating the iron with zinc. The advantage of the latter operation is that it obviates carrosion; while annealing increase its toughness and pliability.

Webster's Process for Making Oxygen.—There are few chemical problems, a solution of which would be of greater commercial importance than the economical preparation of oxygen gas. By the kindness of the proprietors of the patent, we have been afforded an opportunity of critically examining every stage of the above process, and are therefore enabled, from personal observation and experiment, to endorse, all the statements made by Mr. J. H. Pepper in the report which he has submitted. The gas is produced from materials of but trifling value, in large quantity, and by an operation requiring no skilled superintendence whatever. At first sight it would seem that the proportion of nitrogen present with the oxygen would tend to render the gas of only slight commercial value. A little consideration will, however, show that this is not necessarily the case. Although pure oxygen is invaluable in the laboratory, and at the lecture-table, its employment in an undiluted form would be impracticable in ordinary metallurgical operations on a large scale, as the intensity of its action would very soon rise to such a degree of violence as to reduce flux, fuel, metal, and furnace into one chaotic liquid mass. It is, indeed, very doubtful whether the mixed gas which is obtained in such abundance under this patent, is not as strong as could be employed in most manufacturing operations, without serious damage to the furnaces and crucibles used. The only case in which we believe a purer gas would be required, is in the metallurgy of the more refractory platinum metals. The intensity of the "lime light" produced with this mixture is necessarily inferior to that obtained with pure oxygen, but it is abundantly sufficient for all ordinary purposes of illumination, and far better than we had anticipated from the composition of the gas. Indeed, it is only by comparing the two lights simultaneously, side by side, that the difference of intensity becomes apparent.—*Chemical News.*

Electro-Magnetic Engine.—Mr. George Fuller Gray, of Bury, has discovered a mode by which the electro-magnetic force can be applied to the production of a continuous and equable rotary motion, available for machinery, at an expense sufficiently small for competition with steam. The machine is compactly designed, forming a structure about three feet square by four in height, and weighing about a ton and a-half. Its construction was carried out in all its details in Mr. Boby's workshop, Bury, and forms a fair test of the well-finished workmanship which is turned out by that establishment. Nor is it the least remarkable feature about the circumstance that a machine so new in its principle and mechanism, and requiring not less nicety than strength in the adaptation of its parts, has been built from the small model, planned, and, for the most part, constructed by Mr. Gray, so successfully that no alteration has been necessary, but when tried with the small battery used for the model it completely fulfilled all the expectations which had been formed of it. It is, we believe, the intention of Mr. Boby, in the event—respecting which he is most sanguine—of the engine proving strong enough for the work, to substitute it for the steam engine by which the machinery in the foundry is driven.

Royal Institution of Great Britain.—The Lectures at the Royal Institution for the coming winter session have been arranged as follows: Christmas Lectures, 1862: Prof. Frankland, six lectures, "On Air and Water" (adapted to a juvenile auditory). Before Easter, 1863: Prof. Marshall, twelve lectures, "On Physiology"; Prof. Frankland, ten lectures, "On Chemistry"; W. Savory, Esq., four lectures, "On Life and Death"; Prof. Max Müller, twelve lectures. After Easter: Prof. Tyndall, seven lectures; D. T. Ansted, Esq., nine lectures, "On Geology"; Prof. William Thomson, three lectures, "On Electric Telegraphy."

It is a law of catalytic metamorphosis, that a body in the act of decomposing, on being added to a fluid in which its own constituents are present, is itself reproduced, exactly as new yeast is formed by the addition of that substance to saccharine liquids containing gluten, and that the only limits to this process of reproduction are the amount of matter present which is capable of undergoing such alteration, or the supervention of some counteracting influence. This change takes place with more certainty when the fluid acted upon contains, among its constituents, the substance from whose transformation the body suffering decomposition was formed. We have a familiar instance of the action in question in the "turning" of milk, when placed in dishes not scrupulously clean, and to which some particles of older milk in a sour state have been allowed to adhere, or when intentionally soured, as in the preparing of the *yaourt* of the Turks, and other pastoral people, by the addition of a reserved leaven of coagulum. Although milk is a homogeneous fluid in a state of quiescence, as compared with the warm blood of the body, which, to use the beautifully comprehensive expression of Liebig, is "the sum of all the organs and tissues in the act of formation," the extreme sensitiveness it displays to fermentive influences, affords an instructive subject for reflection. Of the oxidizable impurities which are found in the atmosphere, few are so disposed to combine with active oxygen as the decomposing effluvia which proceed from the morbid and putrefying bodies, and the effete excreta of men and other animals. When in a condition for combination, their elements form, with that substance, compounds of a most permanent nature.

Erratum: p. 283.—In the abstract of the Report of the Committee on Standards of Electrical Resistance, for $\frac{\text{meter}}{\text{seconds}}$ read $\frac{\text{millimeter}}{\text{seconds}}$.

All Letters, Works for Review, and other Communications to the Editor, should be addressed to the Office, 32, Paternoster Row, London.

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The Electrician.

Vol. II. No. 52.—October 31, 1862.

CONTENTS:

	Page		Page
The Chemical Theory of the Voltaic Couple	301	The Persian Gulf Cable	307
On the Conduction of the Atmosphere	302	The Family of the late Mr. Suter	307
Some Considerations on the Principles of Electrical Conduction and Accumulation	302	Harrison's Electro-Magnetic Printing Press	307
The Galvanic Circuit Investigated Mathematically	304	Prices Current of Insulating Materials	307
Examination of Various Cables, &c.	305	Telegraph Shares	307
Recent Patents	306	Correspondence	307
		Telegraphic News	308
		Miscellanea	308
		To Correspondents	308

THE CHEMICAL THEORY OF THE VOLTAIC COUPLE.

[Continued from page 290.]

As we have seen from Professor Schonbein's paper (p. 284), a plate of platinum, gold, silver, or even copper, becomes negatively polarised when exposed for a short period to the action of the electrical brush issuing from a metallic point attached to the prime conductor of an electrical machine, charged either positively or negatively. The effect occurs with greater rapidity when the point of discharge is formed of a metal which becomes oxidised with difficulty; it is entirely prevented when either the point of emission or the metallic plate is moistened with water or heated.

The following experiment shows that the actual passage of electricity *through* atmospheric air, or a gaseous mixture containing oxygen, is not necessary for the production of the peculiar conditions under which the polarisation of the plates may occur. A tube of glass is coated externally with tin foil to within an inch or two of its extremities, and so disposed that a succession of discharges from the machine may traverse its outer surface. A smaller glass tube of considerable length may be fitted, by means of a cork, into one of the extremities of the coated tube, and the other extremity is connected, by a piece of india-rubber tubing, to the nozzle of a pair of bellows. A current of air is then propelled through the arrangement, while the electrical discharges are taking place, and, under these circumstances, ozone is formed, and a strip of platinum at the extremity of the smaller glass tube becomes strongly polarised. The same effect takes place when the armature of the tube is simply charged from the machine.

Negative polarisation also occurs when the above-mentioned metals are plunged into an atmosphere of oxygen gas, obtained by the electrolysis of water, or into a vessel containing a stick of phosphorus, partly immersed in water. The electro-negative bodies, *chlorine* and *bromine*, possess a similar action. In the electrolysis of water, the positive electrode, when of platinum or gold, becomes negatively polarised.

It is questionable whether oxygen gas, free from ozone, is capable of producing polarisation; we have not found this effect to take place, in any perceptible degree, when means had been adopted for the separation of this principle. The result obtained in the experiment of Matteucci,* by immersing two strips of platinum, respectively, into (pure) oxygen and hydrogen gases, appears to be due merely to the polarisation of the metal immersed in the hydrogen. Thus the current subsequently produced, when the pieces of metal are placed in water and connected through a galvanometer, does not differ in intensity from that obtained with a positively polarised plate and one in its normal condition.

When a *negatively* polarised plate is associated with an unpolarised plate of the same metal, in the form of a voltaic couple, a temporary current is produced when the elements are united by a metallic conductor, the direction of which, through the fluid, is from the unpolarised to the polarised metal. In this case, the ordinary conditions under which the current takes place are reversed. Instead of consuming an electro-positive body, such as zinc, in the production of the voltaic effect, we originate the action by means of the electro-negative oxygen, and, instead of obtaining the evolution of hydrogen at the negative electrode, oxygen becomes liberated at the surface of the *positive* element. The *rationale* of what takes place, is obviously the converse of that we have given in explanation of the voltaic action originated by the positively polarised electrode. The negative element exerts its electro-attraction for the hydrogen of the fluid molecules, disposing the oxygen atoms in the direction of the unpolarised plate; and, under the influence of a double attractive force, electrolytic decomposition and conduction occur.

The currents produced by polarised plates have been termed "secondary currents," and certain arrangements, first contrived by Ritter for their exhibition, are known as "secondary" batteries. Secondary currents of considerable electromotive power, due to the polarisation of *both* electrodes, may readily be shown by the following means, which we give somewhat in detail for the benefit of the less advanced student of electricity:—To the terminal plates of a battery of several couples, two wires are attached so that they may readily be disconnected from the battery and united together. One of the wires is connected directly to a strip of platinum foil and the other to a tolerably sensitive galvanometer. The other terminal of the galvanometer is connected with a piece of wire, to which is attached a second electrode of platinum. The electrodes are now placed in a vessel of pure water, or water acidulated with pure sulphuric acid, and a voltaic current, indicated by the galvanometer, will traverse the circuit, effecting the electrolytic decomposition of the fluid. In a few minutes the wires may be disconnected from the battery and brought into contact with each other, when the original indication of the galvanometer will be reversed, showing the existence of a temporary current in the contrary direction to that from the battery.

The two polarised strips of platinum constitute a "secondary couple." In forming a "secondary battery," a number of intermediate plates may each be made to perform the functions of a positive and negative element in metallic connection. Thus, a number of plates of platinum, silver, or copper may be cemented into a trough, like the plates of a Cruikshank's battery. Upon immersing into the terminal partitions the electrodes attached to the poles of an ordinary battery, the opposite surfaces of each plate became respectively polarised positively and negatively, and, upon removing the battery from the circuit, and substituting for it a galvanometer, a secondary current of considerable power will deflect the needle of the galvanometer in a direction contrary to that of the original deflection. The use of secondary batteries constructed with plates of lead has been suggested as a means of neutralizing, in submarine circuits, the static charge communicated to the wire by the battery employed in working the line.

When a positively polarised plate of platinum, silver, or copper is placed in opposition to a plate of zinc, in pure or acidulated water, the current, however feeble, is always in the direction from the zinc to the fluid; and, when the fluid is maintained at a low temperature, the original degree of polarisation appears to be indefinitely preserved. The latter fact tends to prove that no decomposition of the electrolyte, by the oxidation of the condensed hydrogen upon the negative plate, can take place while the fluid is polarised by the positive zinc, so that its *hydrogen* atoms are turned towards the negative plate. More conclusive experimental evidence in regard to this point would be obtained by collecting the hydrogen evolved from the negative element of a couple with a positive of chemically pure zinc, immersed in distilled water, free from air, and acidulated with pure sulphuric acid. This experiment, if performed with every suitable pre-

* *Lezioni di Fisica*, 2nd edition, Pisa, 1844, p. 288.

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caution and great care, would, we have reason to believe, tend to establish the view that the action of the condensed hydrogen is limited to the reduction of the electromotive force, by diminishing the degree of polarisation, and, to the resistance it opposes to the passage of electricity, in virtue of its non-conducting character.

This view, however, is in opposition to that which has been adopted by Gavarret and others to explain the rapid diminution of power in the zinc-copper couple, and the difference of intensity between this couple, that of Daniell, and that of Grove. According to Gavarret, while the zinc of the first-mentioned couple is being oxidised and dissolved, the condensed hydrogen upon the negative element is also being oxidised. The solution of the zinc it termed the "positive force in the battery," the decomposition of water by the condensed hydrogen is termed the "negative force." In the couples of Daniell and Grove, the positive force is the same; while the negative force in the former is the reduction of copper from the sulphate, and in the latter the oxidation of hydrogen by nitric acid, which is supposed to generate a current, which tends to pass in the opposite direction to that produced by the solution of the zinc. "The electromotive force in each of these couples," says M. Gavarret, "is, in reality, the excess of the positive force over the negative force. The positive force being the same in each of these combinations, the intensities of the currents they furnish should vary in inverse ratio to the intensities of the three corresponding negative forces. We know, on the other hand, that the intensity of an electromotive force depends upon the energy of the chemical affinities brought into play in originating it. Now, of the three decompositions which produce the *negative* forces, the decomposition of water is that which represents the most powerful chemical action, and the reduction of sulphate of copper is again effected with greater difficulty than the reduction of nitric acid. The negative force in the couple of Volta is then greater than that in Daniell's couple, and that in Daniell's couple is greater than that in Grove's couple; consequently, the *resulting electromotive forces* in these three combinations should become classed in inverse order. These theoretical considerations agree very well with the results of experience, and explain wherefore, other things being the same, the current of the Daniell couple is more intense than that of Volta's couple, and weaker than that of Grove." We propose to submit these principles to some further examination.

(*To be continued.*)

ON THE CONDUCTION OF THE ATMOSPHERE.

BY LATIMER CLARK, M. INST., C.E.

In the insulation of telegraph wires, it becomes an interesting question to ascertain whether the atmosphere, either in a dry or moist state, is itself a sensible conductor of electricity. It is well known that. during wet fogs, the insulation of even the best lines become very imperfect, and it is extremely difficult to work through long distances. This effect is so marked that almost all who have the practical charge of telegraphs, agree in ascribing a great portion of the loss of electricity and the "contact" (as it is termed) between the wires to actual conduction, through the atmosphere, from wire to wire, or from the wires to the earth, and the French telegraphists appear unhesitatingly to accept the same belief. The point remains still to be decided, but I incline to the opinion that no *sensible* loss of electricity takes place to or through the atmosphere in practical working, and that almost the whole leakage takes place over the surfaces or through the interior of the insulators and posts.

With higher tensions this would of course not be the case, for all are familiar with the escape of electricity from highly electrified points, and Mr. C. F. Varley has lately pointed out, as a caution, that a Peltier's electrometer charged with 300 or 400 cells rapidly loses its electricity if a lighted candle be brought anywhere in its vicinity, and has shown that the hot air over a gas flame conducts a very sensible current of electricity.

The following experiments, bearing on the question, were made at the works of the Electric Telegraph Company at Camden Town, in the winter of 1860–61. Two poles were fixed at a distance of about 300 feet apart, and a wire stretched between them at a height of 12 feet from the ground. A similar wire was attached on separate poles at the same height, and at one foot distance from the other throughout its length. Great care was taken that the poles did not touch each other. Each of the two suspended wires was very carefully insulated at each end, and the insulators, while under experiment, were kept hot and dry by rings of red hot iron supported round them. Sheets of wetted canvas, 10 feet long, were suspended from each wire along its whole length, exposing two surfaces of 2800 feet of canvas, at a distance of one foot asunder. An extremely delicate galvanometer, with 30,500 turns of wire, was connected from one surface of canvas to the ground, while a battery of 500 cells was connected to the other surface; and this experiment was repeated both during dry weather, and in the early morning, during some of the densest and wettest fogs I have ever witnessed. At first there appeared evidences of conduction from surface to surface, but as greater precautions were taken, these disappeared, and not the slightest indication of current could be perceived on the galvanometer, although the charge caused by the induction was distinctly perceptible. This experiment is only a negative one, and can by no means be considered as settling the question; but as far as it goes, it is opposed to the view, that any sensible quantity of electricity is conveyed away by the atmosphere itself. Further experiments on the subject would be very interesting.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 292.]

In future, therefore, in speaking of the "tension" of a conductor, or of any point in a conductor, it is to be understood that this implies its tension to any point in the earth, it being also assumed and understood that no tension exists between any two points in the earth.

With this understanding, I will now proceed to describe the relation between the tensions existing in the case of a source having both its poles connected to insulated conductors, and the change in the tensions which takes place when one of these conductors is increased, decreased, or touched to earth; and will show that the various tensions and their changes, under different varying circumstances, as measured by electrometers connected in different ways between the poles of the sources themselves, and between each pole and the earth, are all explicable, by simply considering the inductive circuit that exists, and finding then, by the formulæ, and methods already given, the proportionate quantities that will be distributed on each electrometer.

Let S (fig. 96) be a source having both its poles insulated from one another, and let an electrometer E have its arms connected to one pole, and the armature to the other; then an inductive circuit will be formed from one pole to the other, the only resistance of which consists of the resistance of the electrometer.

If we apply this same electrometer in the same way to different sources, then, since the resistance of the inductive circuit in each case is constant, the quantity accumulated on the electrometer will depend on the nature of the source itself; or, in fact, the electrometer becomes a measure of the tension existing directly between the poles of the source, or a measure of the "electromotive force" of the source. If the source be a single voltaic element, the effect on the electrometer becomes a measure of what Ohm terms "a tension," or what, in modern language, is termed the "electromotive force of a single element." If the

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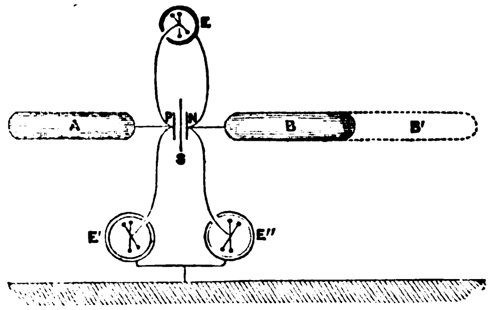
source consists of a battery of several elements, then the electrometer would measure what Ohm terms, "the sum of all the tensions," or what, in modern language, would be termed, the "electromotive force of the battery;" or, simply, "the electromotive force."

Fig. 96.



If one of the poles of the source be connected to the earth, not the slightest difference in the effect on the electrometer E will be produced. For it will be seen that any inductive circuits which exist between the two poles of the source, other than that in which E is situated, have no resistance in common with that of E, and, consequently, by what has already been shown, page 96* (Part I), these parallel circuits cannot affect the quantity in the circuit in which E is situated. Thus, if the positive pole is connected to the arms of the electrometer, and the negative pole to the armature, a circuit exists simply between the exposed connecting wires, and this circuit is simply a parallel, or branch circuit, to that in which the resistance of the electrometer E is situated, and these circuits have no common resistance. If the positive pole is now connected to earth, then a circuit will exist, the resistance of which consists the resistance between the earth (together with all surrounding objects) and the outside of the armature of the electrometer E, and its connecting wire. This, again, has no resistance common with the circut in which E is situated. In the same way, if conductors A and B be connected to the two poles of the source, an inductive circuit will be formed, partly directly between A and B in straight and curved lines, and partly from A to the earth and surrounding objects, and thence to B. Still such circuit will, for the same reasons as in the other parallel circuits traced, leave the effect on the electrometer E unaltered.

Suppose, now, the electrometers E′ and E″ be connected in the manner shown in the figure between the poles of the source and the earth, and surrounding objects.

Then these electrometers will measure the tension of the poles of the source to which they are respectively connected, and the difference of these tensions must, from what we have already said, be equal to the tension shown by the electrometer E.

Now, it will be seen, that the electrometers E′ and E″ form an inductive circuit, having two successive resistances; and, if we suppose all the electrometers similar, then the total resistance of this circuit is exactly double that of the circuit formed by the electrometer E; the quantity on any one surface of this circuit will, therefore, be half that on the electrometer E, and, consequently, each of the electrometers, E′ and E″, will indicate a tension exactly half of that existing between the poles of the source, and which is measured by the electrometer E; that electrometer connected to the positive pole indicating a positive, that at the negative pole a negative tension. Thus, if electrometer E′ measures a tension of +5, that at E″ will give −5, and that at E a tension of 10, indicating a difference of tension between the poles of 10; the sign to be attached to this quantity depending on which pole we chose to take as our point of reference.

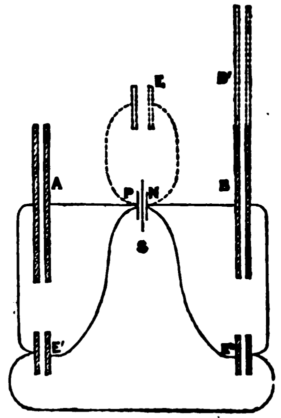
The equality between the tensions shown by the electrometers, E′ and E″, will only exist, however, as long as the inductive resistances between the earth (or surrounding objects connected to earth) and the conductors, A and B, are equal. For, if the inductive resistance between B and the earth is reduced in any way, as for instance, if the conductor B is increased in size to B′, or if conductors connected to earth are approached to B, the quantity on the electrometer E″ will fall, indicating a less tension between the negative pole and the earth, at the same time the quantity on the electrometer E″ will increase by exactly the same amount, indicating a corresponding increase of the tension between the positive pole and the earth, whilst the electrometer E will remain unaffected, indicating that the tension between the two poles, or the difference of tension existing between each pole and earth is the same as before. Thus, if the conductor B is so increased as to reduce the tension shwon by E″ to −2, that at E′ will rise to +8, whilst the electrometer E will still indicate 10.

These effects are all easily explicable, by simply considering the inductive circuits that exist, and the alteration that is caused in the resistances of these circuits by increasing the length of the conductor B, and thus reducing that inductive resistance, of which the surface of B forms one of the bounding surfaces.

To simplify the consideration of this, it is better to consider, or imagine, the conductors A and B surrounded by conducting cylinders connected to the earth, in which case the several inductive resistances of the circuit will have more definite shapes than if we suppose the conductors A and B are simply opposed by the flat surface of the earth below them, in which latter case, indeed, it would be impossible to trace the ratio existing between any increase of the conductors, and the indefinite inductive resistance separating them from the earth, unless that increase was produced by a simple increase of length.

To put the problem, however, into a still more analysed and simple form, it is better to consider the conductors A and B, and the arms of the electrometers E′ and E″, replaced by flat plates, (fig. 97), A and B and E′ and E″, all opposed to similar plates connected together, whilst the electrometer E′ is represented by

Fig. 97.



two flat plates connected direct to the two poles of the source. Then it is evident, from what has been already pointed out, the electrometer E will be unaffected by any alterations in the other inductive circuits, and, therefore, we may still further simplify the problem by neglecting this resistance altogether.

We have, therefore, the inductive resistance between the conductors A and B (fig. 96) and the earth, represented by the resistance between the plates A and B (fig. 97) and their opposing plates; and in the same way the resistances of the

* As the earlier part of my contributions to The Electrician have now been fully published in book form, under the title of "A Treatise on Electrical Accumulation and Conduction" (Part I.), I shall in future refer to the pages and figures of that work, instead of to The Electrician.

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electrometers are represented by the small plates E′ and E″, and their opposing plates and the tensions at each pole of the source, and the earth will be proportioned to the quantities accumulated on their same plates E′ and E″.

Then, if R' = resistance between plates E′ = 90
R'' = " " " E″ = 90
r = " " " A = 12
r' = " " " B = 12

Then the resistance of the whole inductive circuit will be expressed by the equation—

$$R=\frac{R'\,r}{R'+r}+\frac{R''\,r'}{R''+r'}=\frac{90\times12}{90+12}+\frac{90\times12}{90+12}=10\cdot5+10\cdot5=21\cdot0.$$

Suppose now, that in this state of the circuit the quantity Q (=100), is the whole quantity generated on one side of the source. Then this quantity will be divided inversely between R′ and r.

Or calling quantity on electrometer E′, q'
" " " plate A, Q′
" " " electrometer E″, q''
" " " plate B, Q″

Then $q'=\frac{Q\,r}{R'+r}=\frac{100\times12}{90+12}=11\cdot7$, this being positive,

and $q''=\frac{Q\,r'}{R''+r'}=\frac{100\times12}{90+12}=11\cdot7$, this being negative.

And, from what has been said, the quantity on the electrometer E will be equal to the difference of these quantities, or

$$\begin{array}{r}+11\cdot7\\-11\cdot7\\\hline 23\cdot4\end{array}$$

Suppose, now, the plates B extended on m times to B′, then the resistance of the whole inductive circuit is expressed by

$$R'=\frac{R'\,r}{R'+r}+\frac{R''\,\frac{r'}{m}}{R''+\frac{r'}{m}}=10\cdot5+\frac{90\times0\cdot8}{90+0\cdot8}=11\cdot29.$$

The quantity generated now on each side of the source will be expressed by

$$Q'=\frac{Q\,R}{R'}=\frac{100\times21}{11\cdot29}=186.$$

The positive quantity, Q′, will divide itself between the plates A and E′ inversely, as the resistances separating them from their opposing surfaces, therefore

$$q'=\frac{Q'\,r}{R'+r}=\frac{186\times12}{90+12}=21\cdot8.$$

And the negative quantity Q′ will divide itself between the extended plates B′ and the plates E′, also inversely, as their resistances, therefore

$$q''=\frac{Q'\,\frac{r'}{m}}{R''+\frac{r'}{m}}=\frac{186\times0\cdot8}{90+0\cdot8}=\frac{148\cdot8}{90\cdot8}=1\cdot6.$$

The electrometer E′ shows, therefore, a tension + 21·8
And the electrometer E″ a tension ... ... − 1·6
And the difference of these is ... ... 23·4

The difference of the tensions of the two poles is still exactly the same as before, and exactly equal to the tension existing between the poles themselves.

If, now, the resistance R″ and r' is reduced to nil by extending the plates B′ infinitely, or connecting them together, then the resistance of the whole circuit will be simply

$$R=\frac{R'\,r}{r'+r},$$

or half what it was at first. The quantity generated on the plates A and E′ will, therefore, now be 2 Q, and

$$q'=\frac{2Qr}{R'+r}=\frac{200\times12}{90+12}=23\cdot4.$$

Thus the electrometer E′ shows a tension ... ... + 23·4
And since the electrometer E″ is out of circuit, its tension will be... 0
And the difference ... ... 23·4

The tension of A has risen to the full tension between the two poles of the source, whilst the tension of B has fallen to zero.

(*To be continued.*)

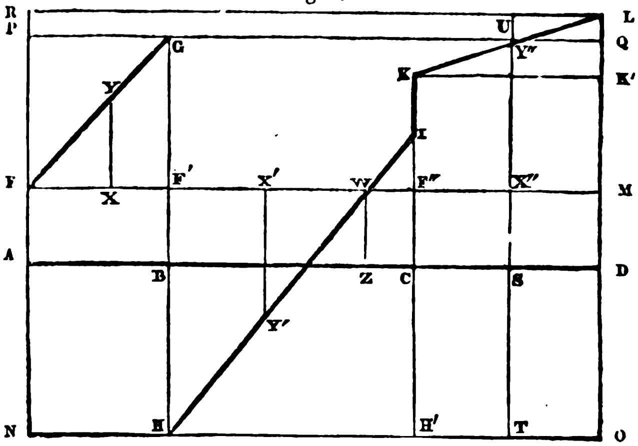
THE GALVANIC CIRCUIT INVESTIGATED MATHEMATICALLY

BY DR. G. S. OHM.

[Continued from p. 293.]

The expression $\frac{A}{L}\cdot\frac{(\lambda)}{(l)}$, denoting the dip of any portion of the circuit, vanishes when L is indefinitely great, while A and $\frac{(\lambda)}{(l)}$ retain finite values. Consequently, if L assumes an indefinitely great value, while A remains finite, the dip of the straight lines representing the separation of the electricity, in all such parts of the circuit, whose reduced length has a finite ratio to the actual length, vanishes, or what comes to the same thing, the electricity is of equal force at all places of each such part. Now, since L represents the sum of the reduced lengths of all the parts of the circuit, and these reduced lengths evidently can only assume positive values, L becomes indefinite as soon as one of the reduced lengths assumes an infinite value. Further, since the reduced length of any part represents the quotient obtained by dividing the actual length by the product of the conductibility and the section of the same part, it becomes infinite when the conductibility of this part vanishes, *i. e.*, when this part is a non-conductor of electricity. When, therefore, a part of the circuit is a non-conductor, the electricity expands uniformly over each of the other parts, and its change from one part to the other is equal to the whole tension there situated. This separation of the electricity, relative to the open circuit, is far more simple than that in the closed circuit, which has hitherto formed the object of our consideration, as is geometrically represented by the lines F G, H I, K L (fig. 8), taking a position parallel to A D. It distinctly demonstrates that the difference between the electrical forces,

Fig. 3.



occurring at any two places of the circuit, is equal to the sum of all the tensions situated between these two places, and consequently increases or decreases exactly in the same proportion as this sum. When, therefore, one of these places is touched abductively, the sum of all the tensions, situated between the two, makes its appearance at the other place,

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at the same time the direction of the tensions must always be determined by an advance from the latter place. All the experiments on the open pile, with the help of the electroscope, instituted at such length by Ritter, Erman, and Jäger, and described in Gilbert's *Annalen*,* are expressed in this last law.

All the electroscopic actions of a galvanic circuit of the kind described at the outset, have been above stated; I therefore pass at present to the consideration of the current originating in the circuit, the nature of which, as explained above, is expressed at every place of the circuit by the equation

$$S = \frac{A}{L}.$$

Both the form of this equation, as well as the mode by which we arrive at it, show directly that the magnitude of the current in such a galvanic circuit remains the same at all places of the circuit, and is solely dependent on the mode of separation of the electricity, so that it does not vary, even though the electric force at any place of the circuit be changed by abductive contact, or in any other way. This equality of the current at all places of the circuit has been proved by the experiments of Becquerel,† and its independency of the electric force at any determinate place of the circuit by those of G. Bischof.‡ An abduction or adduction does not alter the current of the galvanic circuit so long as the only act immediately on a single place of the circuit; but if two different places were acted upon contemporaneously, a second current would be formed, which would necessarily, according to circumstances, more or less change the first.

The equation

$$S = \frac{A}{L}$$

shows that the current of a galvanic circuit is subjected to a change, by each variation originating either in the magnitude of a tension or in the reduced length of a part, which latter is itself again determined, both by the actual length of the part, as well as by its conductibility, and by its section. This variety of change may be limited, by supposing only one of the enumerated elements to be variable, and all the remainder constant. We thus arrive at distinct forms of the general equation corresponding to each particular instance of the general capability of change of a circuit. To render the meaning of this phrase evident by an example, I will suppose that in the circuit only the actual length of a single part is subjected to a continual change; but that all the other values denoting the magnitude of the current remain constantly the same, and, consequently, also in its equation. If we designate by x this variable length, and the conductibility corresponding to the same part by κ, its section by ω, and the sum of the reduced lengths of all the others by A, so that $L = \Lambda + \frac{x}{\kappa \cdot \omega}$, then the general expression of the current changes into the following:

$$S = \frac{A}{\Lambda + \frac{x}{\kappa \cdot \omega}};$$

or if we multiply both the numerator and denominator by $\kappa\,\omega$, and substitute a for $\kappa\,\omega$ A, and b for $\kappa\,\omega\,\Lambda$ into the following:

$$S = \frac{a}{b + x},$$

where a and b represent two constant magnitudes, and x the variable length of a portion of the circuit, fully determined with respect to its substance and its section. This form of the general equation, in which all the invariable elements have been reduced to the smallest number of constants, is that which I had practically deduced from experiments to which the theory here developed owes its origin.§ The law which it expresses relative to the length of conductors, differs essentially from that which Davy formerly, and Becquerel more recently, were led to by experiments; it also differs very considerably from that advanced by Barlow, as well as from that which I had previously drawn from other experiments, although the two latter come much nearer to the truth. The first, in fact, is nothing more than a formula of interpolation, which is valid only for a relatively very short variable part of the entire circuit, and, nevertheless, is still applicable in very different possible modes of conduction, which is already evident, from its merely admitting the variable portion of the circuit, and leaving out of consideration all the other part; but all partake in common of this evil, that they have admitted a foreign source of variability, produced by the chemical change of the fluid portion of the circuit, of which I shall speak more fully hereafter. I have already treated, in other places, more at length of the relations of the various forms of the law to one another.

From the numerous separate peculiarities of the galvanic circuit resulting from the general equation

$$S = \frac{A}{L},$$

I will here merely mention a few. It is immediately evident that a change in the arrangement of the parts has no influence on the magnitude of the current if the sum of the tensions be not affected by it. Nor is the magnitude of the current altered, when the sum of the tensions ,and the entire reduced length of the circuit, change in the same proportion; consequently, a circuit, the sum of whose tensions is very small in comparison to that of another circuit, may still produce a current, which, in energy, may be equal to that in the other circuit, when merely that which it loses in force of tensions is replaced by a shortening of its reduced length. In this circumstance is the source of the peculiar difference between thermo- and hydro-circuits. In the former only metals occur as parts of the circuit; in the latter, besides the metals, aqueous fluids, whose power of conduction, in comparison to that of the metals, is exceedingly small; on which account the reduced lengths of the fluid surpass, beyond all proportion, those of the metallic parts, with in all respects equal dimensions, and even remain considerably greater when diminished by shortening their actual lengths, and increasing their sections, so long, at least, as this diminution is not carried too far. And thence it is that the reduced length of the thermo-circuit is, in general, far smaller than that of the hydro-circuit, whence we may infer a tension smaller in the same proportion in the former, although the magnitude of the current, in the thermo-circuit, cedes in nothing to that in the hydro-circuit. The great difference between a thermo- and hydro-circuit, both of which produce a current of the same energy, is evident when the same change is made on both, as will be shown in the following consideration. Let the reduced length of a thermo-circuit be L, and the sum of its tensions A, the reduced length of an hydro-circuit m L, and the sum of its tensions m A, then the magnitude of the current in the former is expressed by $\frac{A}{L}$, in the latter by $\frac{m\,A}{m\,L}$, and is consequently the same in both circuits. But this equality of the current no longer exists if the same new part λ of the reduced length be introduced into both, for then the magnitude of the current is in the first

$$\frac{A}{L + \lambda},$$

in the second

$$\frac{m\,A}{m\,L + \lambda}.$$

If we connect with this determination an evaluation, even if merely superficial, of the quantities m, L, and λ, we shall readily be convinced that in cases where the simple hydro-circuit can still produce in the part λ actions of heat or chemical decomposition, the simple thermo-circuit may not possess the hundreth, and in some cases not the thousandth part of the requisite force, whence the absence of similar effects in it is easily to be understood. We are also able to understand why a diminution of the reduced lengths of the thermo-circuit (by increasing, for instance, the section of the metals constituting it), cannot give rise to the production of those effects, although the magnitude of its current may be increased by this means to a higher degree than in the hydro-circuit producing such effects. This difference in the conductibility of metallic bodies and aqueous fluids, is the cause of a peculiarity noticed with respect to hydro-circuits, which it is here, perhaps, the proper place to mention. Under the usual circumstances, the reduced length of the fluid portion is so large, in comparison to that of the metallic portion, that the latter may be overlooked, and the former alone taken instead of the reduced length of the entire circuit; but then the magnitude of the current in circuits which have the same tension is in the inverse ratio to the reduced length of the fluid portion. Consequently, if merely such circuits are compared in which the fluid parts have the same actual lengths and the same conductibilities, then the magnitude of the current in these circuits is in direct ratio to the section of the fluid portion. However, it must not be overlooked, that a more complex definition must take the place of this simple one, when the reduced length of the metallic portion can no longer be regarded as evanescent towards that of the fluid, which case occurs whenever the metallic portion is very long and thin, or the fluid portion is a good conductor, and with unusually large terminal surfaces.

(To be continued.)

* Vol. viii., xii., and xiii.
† *Bulletin Universel. Physique.* Mai, 1825.
‡ Kastner's *Archiv.*, Vol. iv. Part 1.
§ See Schweigger's *Jahrbuch*, 1826, part 2.

EXAMINATION OF VARIOUS CABLES, ETC.

At the present time, when the subject of submarine telegraphy occupies so much of the attention of scientific men and the public at large, the following results of a careful examination of various submarine insulated wires, may prove interesting if not instructive, and beneficial to the future of the important science of telegraphy.

The failure of the Red Sea telegraph line, and the absence of any information as to the *true state* of this submerged cable, from the gentlemen employed to attempt its recovery, are still a cause of considerable uneasiness as to the practicability of submarine lines in the East.

I have been favoured with a short length of the Red Sea Cable, recovered by Mr. Latimer Clark. The iron sheathing is much cor-

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roded and severed, evidently by overstraining. The hemp is in a very good condition. The gutta percha has partially undergone a change by the absorption of a resinous compound introduced between the layers; it is very hard and brittle. The quality of the gutta percha is bad. Impurities and air cavities are exceedingly numerous. Insulating quality very low. The material employed in the construction of the Malta and Alexandria core is better cleansed; but the quality of the gutta percha is far from being good. The resinous compound is absorbed in this cable, as in that of the Red Sea. I have a piece of gutta percha insulated core furnished me, which has been submerged for five years in the sea. The quality of the material is extremely good; very free from impurities, and the insulation far superior to that of either the Red Sea or Malta cables. The specimens above enumerated were examined by gentlemen of long experience in the manufacture of gutta percha, and they fully agreed with the results of my investigations. The recent cores manufactured by the Gutta Percha Company much resemble in quality those manufactured about eight years ago. Dr. Erselbach makes the latter 2000 times better insulated than the Atlantic core. The statement is ridiculous. I have also examined india rubber insulated cores. One piece which I have had in my possession for upwards of three years, and which was cut from a length of one mile sent by Messrs. Wells and Hall to be tested, under the direction of the Telegraph Committee of the Board of Trade. It has been kept all that time in my specimen box, free from the action of light. It is in excellent condition. The mile of wire, from which the piece had been cut, has now been in water for three years. Mr. Hall has kindly allowed me to cut out a piece out of the middle of that wire, to test against the one in my possession. The part which had been submerged, had a superior insulating quality. The rubber was clearer and more tenacious, not the least manifestation of a chemical action between the copper and the india rubber. I have also examined a piece of Messrs. Silver and Co.'s india rubber covered wire, which I have kept in a dark and damp cellar for three years. No chemical action whatever had taken place between the rubber and the copper wire. The rubber had assumed a darker and a more solid appearance. A portion of an insulated wire, manufactured by Messrs. Siemens, was also examined, consisting of two coatings of India rubber, and one of Wray's compound. The coatings were loose. No ahesiveness, and the compound evidently impaired, as in the case of india rubber insulated wires, when again covered with gutta percha. This fact is confirmatory of many hundreds of experiments, which I have made during the last three years, namely that we must look for superior and permanent insulation by the employment of pure gutta percha or pure india rubber by itself, not mixed in layers or as a compound. I have also tested the Persian Gulf core against the Red Sea, and the Malta and Alexandria cable, the result is greatly in favour of the former; The public need not any longer confine itself to *one* material. We have two gums well adapted for the requirements of submarine telegraphy, provided they are properly purified and treated; where one fails the other succeeds, according to the degrees of temperature to which they may be subjected in the course of transit, &c. In a future communication I shall furnish you with the details of the electrical tests to which the specimens were subjected, and also with a few observations respecting the extraordinary insulation experiments conducted by Dr. Esselbach, at the Glo'ster Road Works, and which are printed in the Appendix to the Government Report on Submarine Telegraphy.

Owen Rowland.

October 30, 1862.

Recent Patents.

665. A. J. Russell, *Edinburgh*, "*Electric conductors for submarine telegraphs.—A communication.*"—*Dated* 12*th March*, 1862.

This invention consists in twisting, coiling, or winding the conducting wires for submarine telegraphs around the cable or core, that is, giving them the form and direction of helical or spiral wires, instead of straight longitudinal wires, as heretofore adopted; and the inventor now uses from one to eight or more such twisted or coiled wires or conductors, the insulation of each being insured by a covering of silk; and over this he now prefers to use a covering or insulator of gutta percha or india rubber, and over this again, a covering of hemp that has been steeped in tar, grease, and such like substances, and over all, the external sheath, composed of small cords of hemp, or of hemp and fine steel wire, that has been steeped in grease, tar, and such like substances.—*Not proceeded with.*

708. A. J. Paterson, *Edinburgh*, "*Electric telegraph cables.*"—*Dated* 14*th March*, 1862.

This invention consists in the employment of a flexible or jointed pipe or tube, or series of tubes, within which the insulating conducting wires are placed. The pipes or tubes possess great tensile strength, and may be made water-tight by gutta percha, india rubber, tarred hemp, or any suitable material, or combination of materials, with or without wire, as circumstances may require. This tubing may be protected from corrosion when made of metal, by galvanizing, or by being coated with gutta percha, marine glue, or any other like protecting agents.

749, J. Banks, *Salisbury-street, Adelphi, London*, "*Electro-magnetic telegraph printing apparatus, or marking instruments.*"—*Dated* 18*th March*, 1862.

These improvements in the arrangement of electro-magnetic telegraph printing apparatus and transmitters, consist in employing two helical coils, which the patentee prefers to place vertically, and to use or employ projecting polar terminations, so that the armature may be attracted upward to the under side thereof, when the polar terminals are applied at the upper ends of the soft iron cores, and instead of employing a bar armature, one end of which is made to come in contact with each pole or polar terminal, he employs a circular armature in the form of a disc, or a ring, and mounts it upon a spindle or rod held and guided parallel to the soft iron cores, with a means of adjustment applied at the step bearing, or pivot. This spindle or rod, with the circular armature, is free to rotate, and so present a different part to each polar terminal, from time to time. The spindle or rod is prolonged beyond the armature, and has on its extremity, either a button-shaped striker, or marker of any convenient shape. The marking part of the apparatus, is carried by the same framing or mounting as the magnetic coils, and thus, if the coils are placed vertically, and the marking or printing apparatus applied above them, the paper strip or ribbon may be indented from the under side, or inked or otherwise marked on its upper face during its passage through the sheath or guide. Instead of employing a rotating disc mounted on a spindle working in fixed bearings, such disc being free to revolve in the direction of the paper, or made to revolve in a contrary direction by means of clockwork, he either employs a roller similar to a printer's inking roller, mounted at a short distance above the paper, and capable of revolving freely, or he employs a thin cake, strip, or rod of solid ink, held or contained in a sheath mounted in a carriage, or supported in any convenient manner above the paper, against the point of which solid ink marker, or against the printer's ink roller, the paper is pressed in contact during the transmission of the electric currents through the helices or coils; thus, on making and breaking contact, dots and spaces, or lines and spaces are formed on the strip of paper.

THE PERSIAN GULF CABLE.

We have much pleasure in inserting the following results of the testing of twenty miles of telegraph wire, insulated, with caoutchouc, constituting the core of the cable intended for the Persian Gulf. The weight of the conductor (a strand of 7 wires) is 270 lbs.; weight of (caoutchouc) insulator, 165 to 170 lbs. to the statute mile.

In testing for insulation a battery of 504 cells was used; one pair of cells giving a deflection of 60° on one of Reid's delicate galvanometers.

The process of testing was the same as for the Malta and Alexandria cable.

The whole of the core, in the condition as specified in the testing, was then handed to Mr. Henly for sheathing.

Date of Testing.	Temperature of Water.	Number of length (1 mile.)	Loss of Insulation in Vacuo.	Loss of Insulation under pressure.
July 29, 1862	74°	1	·25°	·5°
"	"	2	0°	0°
"	"	3	0°	0°
August 5	"	4	0°	0°
"	"	5	0°	0°
"	"	6	0°	0°
"	"	7	0°	0°
August 13	"	8	0°	0°
"	"	9	0°	0°
"	"	10	0°	0°
"	"	11	0°	0°
"	"	12	0°	0°
"	"	13	0°	0°
"	"	14	0°	0°
"	"	15	0°	0°
August 15	"	16	0°	0°
"	"	17	0°	0°
"	"	18	·5°	0°
"	"	19	·25°	·25°
August 20	"	20	0°	0°

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THE FAMILY OF THE LATE MR. SUTER.

We recently* had to announce the death of Mr. W. Suter, which followed closely upon his exertions in the arduous and important duties connected with the repair of a portion of the Red Sea Cable.

It has come to our knowledge that, through his premature decease, the widow and fatherless children of this well-known and deservedly esteemed telegraphist have been left unprovided for. The simple statement of this painful fact may be sufficient to cause some who have known Mr. Suter during the period of his lengthy and active service in the operations of Submarine Telegraphy, and others who have been sufficiently connected with such operations to feel a peculiar interest in this case of distress, to join in a subscription for the purpose of placing the family of Mr. Suter beyond the reach of absolute want. We have little doubt that a sufficient sum may be thus collected to enable this family,—now deprived of their only support beyond the Providence which works, through human kindliness, the good both of the giver and the receiver, to obtain some small *coing de vantage* in the busy world of labour, whence they may acquire independence through their own exertions.

In all professions and trades such cases and such appeals occur—let us hope that the first public call upon our sympathies which has taken place amongst Electricians and Telegraph Engineers will prove, by its results, that however much their opinions and interests may differ in matters of science and trade, they are still, at least, united in those cases which call forth the best and noblest sentiments of our natures.

Mr. T. Piper, the Publisher of the *Electrician*, has consented to receive any subscriptions which may be forwarded for the purpose we have referred to. These, when handed to Mrs. Suter, will be acknowledged in our columns.

HARRISON'S ELECTRO-MAGNETIC PRINTING PRESS.

In one of the narrow lanes which cross the western annexe of the International Exhibition, amidst spinning and roving machines, their is exhibited in action, what seems the kernel of a new system of printing, of so remarkable a charactor as to deserve some notice in our pages. We allude to a small hand printing press, which, by some occult energy, prints with the tip of a finger. You see a small page of type with a tiny tympan hinged on to it like the fly leaf of a vignette. The attendant rubs his inking roller on a neighbouring slab of marble with a peculiar turn, twist, and dab, until he thinks he has sufficient for a single impression. He then passes it once or twice over the types, and releasing a small spring, tips the tympan over with his little finger, and touching the spring again, tips it back. Somehow a sharp impression of the type is printed on the slip of paper previously laid on the tympan. You feel puzzled to account for the evident traces of pressure on the reverse of the printed slip, and begin to scrutinise the apparatus a little more closely. Ah! there it is, you exclaim, as you detect a couple of copper wires attached to a pair of binding screws on the table. We have electricity at work, and these are the channels by which the hidden power is conveyed. Look under the table, and trace the wires back to their origin, and you become aware of a couple of porcelain jars, constituting two cells of a Daniell's battery. Continue the scrutiny, and you will find a pair of electro-magnets on the table of the press, and a corresponding armature on the platten. The seeming mystery is now plain.

The inventor, Mr. Harrison, contemplates applying electro-magnetism to printing on a large scale, and for stamping and embossing. Whatever the capabilities of the new form of power may be for those purposes, we can speak with the certainty of its practicability and entire success on the scale of a hand press of an octavo size, as shown at the Exhibition.

The main principle of the invention consists in obtaining the necessary pressure by means of electro-magnets, and keepers which are brought close together on moving the platten over the type, and as this motion is made to complete an electric circuit around the magnets, a powerful pressure for a short distance is at once obtained, without the exertion of any manual force or complication of levers, screws, or cams, usually employed for the same purpose. Touching a a spring breaks the circuit of the current, and instantly releases the pressure for another impression.

The magnetic power, as before stated, is derived from two cells of a Daniell's battery, the zinc and copper elements being excited by salt and water. The copper cells are filled with tow or cotton, which serves to sustain crystals of sulphate of copper on the surface of the liquid, and as these slowly dissolve maintain the power of the battery. The expense of materials required for a battery to work a machine of the size we have mentioned is said to be about two shillings per week.—*Engineer.*

* Page 117, vol. 2.

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Fine Para	2s. 1d.	per lb.
Negro	1s. 3d.	"
Java	1s. 6d.	"

Gutta Percha

Fine	2s. 4d. to 2s. 6d.	per lb.
Genuine Mixed	1s. 9d. to 2s. 0d.	"
Ordinary Reboiled	10d.	"

Firm markets in both articles.

October 29, 1862. Wm. Kirkmann,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic, A.	100	54 to 57	——
20	Do. B 7 per cent. till 1862 .	all	19 to 21	——
20	Do. C	—	——	——
Stock	Electric Telegraph . .	100	100 to 103	——
25	Do. New	20	——	——
5	London District Telegraph .	4¼	4 to 3 dis.	——
10	Lond. & S. Ireld. Direct Tel.	2	— pm.	——
10	Mediterranean Extension Tel.	all	3 to 4	——
10	Do. 8 per cent. pref.	all	——	——
1	Submarine Telegraph, scrip.	all	⅜ to ⅝	——
1	Do. registered . . .	all	⅜ to ⅝	——
10	Do. " . . .	all	4 to 6	——
2	Telegraph to India . .	1	¾ to ½ dis.	——
5	United Kingdom Telegraph .	3	½ dis. to par.	——

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of The Electrician.

Sir,—Can you or any of your readers, kindly inform me whether it has ever been proved by experiment, what are the best proportionate lengths of primary and secondary wires for an induction coil with a given amount battery power; if so, if the primary wire is shorter, will an increase of battery power give the same effect. Also, can you inform me what ebonite is, whether it is a composition or not, if it is a composition, and is the subject of a patent, who is the patentee, or where would it be obtainable. If it is a composition and not patented, the component parts will oblige.—I remain, your obedient servant. W. Johnson.

"AERIAL LINE ACROSS THE MOUTH OF THE MERSEY."

To the Editor of The Electrician.

Sir,—In one of your last numbers you have an article under the above heading, and as the information you have received is incorrect, I take the opportunity of stating that the idea a replacing the submarine cable by an aërial line, has not been decided upon, nor is there any probability of a wire being thrown across the Mersey between Liverpool and Birkenhead, the Mersey Docks Harbour Board having, for the present at any rate, decided upon maintaining the cable.

It is true the cable has, on several occasions, been broken by vessel's anchors, notwithstanding it is laid considerably to the northward of the Rock Lighthouse, but as regards the insulation of the wires, it is as perfect as when first laid down.—I am sir, your obedient servant,

John G. Gisborne.
Telegraph Engineer, Mersey Docks and Harbour Board.
October 23rd, 1862.

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To the Editor of THE ELECTRICIAN.

SIR,—You or any of your readers would much oblige, by informing me if there is any source from which I can obtain statistics of the progress of telegraphy from its first introduction into public use, to the present time, more especially with regard to the number of miles of line and of wire, from year to year, both in England and abroad.—I am sir, yours,

London, October 29th, 1862. ENQUIRER.

Telegraphic News.

The submarine telegraph between the Isle of Man and the northwestern coast of England has been raised and relaid.

ACCIDENT THROUGH THE FALL OF AN AERIAL WIRE.—During the height of the gale on Thursday morning, a serious accident happened on Blackfriars Bridge, by which two persons were severely injured. It may be stated that the District Telegraph Company's wires run across the river over the bridge, the wire springing from Mr. Harvey's, the Cross Key's Tavern, Blackfriars-road to a house on the Middlesex shore. About eleven o'clock one of the Islington omnibuses was proceeding over the bridge, when suddenly a loud noise was heard, and a gentleman was hurled from the top of the omnibus on to the roadway, falling with great force on his head, It was found that the telegraph wire had snapped with the fury of the gale, and coiled round the neck of the unfortunate man, dragging him from his seat. He was picked up in a senseless state, and it was found he had sustained most serious injuries to his scull. We are sorry to observe that this accident ultimately proved fatal. The name of the sufferer is Mr. M. Jacobs, aged 23. The broken wire on the Middlesex side of the bridge caught the body of a man in a cart, and hurled him to the ground, causing him also severe injuries.

THE following letter has been addresed by Messrs. Glass, Elliot, & Co. to Mr. Cyrus W. Field, who has returned to this country for the purpose of promoting the establishment of a transatlantic telegraph.

10, *Cannon Street, E.C., London, October 20th*, 1862.

CYRUS W. FIELD, Esq.,

ATLANTIC TELEGRAPH COMPANY.

DEAR SIR,—In reply to your enquiries we beg to state—

That we are perfectly confident that a good and durable submarine cable can be laid direct from Ireland to Newfoundland, and are willing to undertake the contract upon the following conditions :—

First.—That we shall be paid each week our actual disbursements for labour and material.

Second.—That when the cable is laid and in working order we shall receive for our time, services, and profit, 20 per cent. on the actual cost of the line, in shares of the Company, deliverable of us in twelve equal monthly instalments, at the end of each successive month whereat the cable shall be found in working order.

We are so confident that this enterprise can be successfuly carried out, that we will make a cash subscription for a sum of £25,000 sterling, in the ordinary capital of the Company, and pay the calls on the same when made by the Company.

Annexed we beg to hand you, for your guidance, a list of all the submarine telegraph cables manufactured and laid by our firm since we commenced this branch of our business, the whole mileage of which, with the exception of the short one between Liverpool and Holyhead, which has been taken up, is at this time in perfect and successful working order. The cable that we had the honour to contract for and lay down for the French Govenment, connecting France with Algeria, is submerged in water of nearly equal depth to any we should have to encounter between Ireland and Newfoundland.

You will permit us to suggest that the shore ends of the Atlantic should be composed of very heavy wires, as from our experience, the only accidents that have arisen to any of the Cables that we have laid, have been caused by ships' anchors, and none of those laid out of anchorage ground have ever cost one shilling for repairs.

The Cable that we should suggest for the Atlantic will be an improvement on all those yet manufactured, and we firmly believe will be imperishable when once laid.—We remain, sir, yours faithfully,

GLASS, ELLIOT, & CO.

Miscellanea.

THE air contained in water, and which can only be totally separated from it by very great care, performs important uses. It serves, as Dr. Faraday said, to separate the particles of water from each other, and its numerous globules, diffused imperceptibly through the fluid, operate like so many minute wedges in forcing the particles apart. Some researches by continental philosophers on the properties of air contained in water and other fluids had led to very curious results. Water, from which air has been carefully excluded, may be heated to a temperature of 270° Fahrenheit, without boiling; which heat is sufficient in ordinary circumstances to raise water to a pressure of three atmospheres. When, however, the temperature is increased above 270°, the water suddenly boils with a most violent explosion. Dr. Faraday said it would not be safe to perform the experiment in that form, but the same phenomenon occurs when water is dropped into highly heated oil, as he exhibited; and the continued small explosions that ensue when the wick of a candle is moistened may be attributed to the same cause. As an exemplification of the manner in which the particles of water adhere when air is not present, some water, in a bent tube, from which the air had been removed was exhibited. The liquid in each branch of the tube remained at different heights, and it required a smart blow to bring it to a level in each. Liquids possess the peculiar property, when exposed to a highly-heated surface, of assuming a spheroidal form, by means of which they are prevented from coming into contact with the heated body, and remain considerably cooler than in a less heated vessel. M. Boutigny, the French chemist, had succeeded in illustrating this property of fluids in many remarkable ways, some of which Dr. Faraday exhibited. A small ingot of polished silver, heated red hot, was immersed in cold water, without any sensible effect at first, but when the silver had become partially cooled, a violent ebullition took place. Some water and some iodine were placed in separate highly heated platinum saucers, in which they were seen to have assumed the spheroidal form, and no perceptible evolution of steam or vapour ensued. When, however, the source of heat was removed, the violet-coloured iodine vapour issued abundantly, and the water flashed into steam. By a modification of the experiment, M. Boutigny had succeed in freezing water, and even mercury, in red-hot vessels.

DR. LARDNER ON THE ELECTRIC TELEGRAPH.—Being at Paris some years ago, I was engaged to share with M. Leverrier, the celebrated astronomer, and some other men of science, in the superintendence of a series of experiments to be made before committees of the Legislative Assembly and of the Institute, with the view of testing the efficiency of certain telegraphic apparatus. On that occasion, operating in a room at the Ministry of the Interior, appropriated to the telegraphs, into which wires, proceeding from various parts of France, were brought, we dictated a message, consisting of about forty words, addressed to one of the clerks at the railway station at Valenciennes, a distance of 168 miles from Paris. This message was transmitted in two minutes and a half. An interval of about five minutes elapsed, during which, as it afterwards appeared, the clerk, to whom the message was addressed, was sent for. At the expiration of this interval the telegraph began to express the answer, which, consisting of about thirty-five words, was delivered and written out by the agent at the desk, in our presence, in two minutes. Thus, forty words were sent 168 miles, and thirty-five words returned from the same distance, in the short space of four minutes and thirty seconds. But surprising as this was, we soon afterwards witnessed, in the same room, a still more marvellous performance. The following experiment was prepared and performed at the suggestion and under the direction of M. Leverrier and myself:—Two wires, extending from the room in which we operated to Lille, were united at the latter place, so as to form one continuous wire extending to Lille and back, making a total distance of 336 miles. This, however, not being deemed sufficient for the purpose, several coils of wire wrapped with silk were obtained, measuring in their total length 746 miles, and were joined to the extremity of the wire returning from Lille, thus making one continuous wire measuring 1082 miles. A message consisting of 282 words was then transmitted from one end of the wire. A pen attached to the other end immediately began to write the message on a sheet of paper moved under it by a simple mechanism, and the entire message was written in full in the presence of the committee, each word being spelled completely and without abridgment, in *fifty-two seconds*, being at the average rate of *five wordi and four-tenths per second!*

To Correspondents.

STUDENT.—You will find a description of the instrument you mention in No. 24, Vol. I.

L. R.—Try any of the best known instrument makers.

B.—If you refer to page 163, Vol. II., you will see a rough specimen of the art, and in No. 48, you will find a very interesting paper on "Electrical Manipulation."

C. D.—Apply to the Editor of the Engineer, 165 Strand, W. C.

A. H. B.—A work entitled "The Electric Telegraph; was it invented by Prof. Wheatstone?" by F. Cooke, Esq., gives a clear, but not very concise history of the electric telegraph. "Dr. Lardner, on the Electric Telegraph," published by Watson and Maberly, 27 Ivy Lane, is a somewhat recent work.

END OF VOL. II.

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